THE EFFECTS OF 60 DAYS OF TRAY RATION CONSUMPTION IN MARINE COMBAT ENGINEERS WHILE DEPLOYED ON GREAT INAGUA ISLAND, BAHAMAS

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This study evaluated the ability of theTray Pack Rations (T Ration) to adequately sustain Marines, without causing excessive weight loss and/or gastrointestinal (GI) symptoms, during a 60-day Marine construction mission. Volunteers (n=85) were randomly assigned to receive either 2 T Ration meals (breakfast and dinner) and 1 Meal, Ready-to-Eat (MRE) (T group), or 2 B Ration meals and 1 MRE (B group). Volunteers (n=19) in the T group (all with a rank of E-4 or below), but none in the B group, dropped for food related reasons. Seventeen volunteers in the T group and 34 in the B group finished the study and remained in their assigned group. Measures obtained were dietary intakes, ration acceptability, and energy expenditure (n=15) deter,ined by doubly-labeled water, subjective GI symptoms and mood states, physical performance and weekly body weights. Neither group reported GI symptoms. The type of ration did not affect sleep, mood or physical performance. Weight losses, which did not significantly differ between ration groups, exceeded the 3% criterion by Day 56. Both groups were in negative energy balance. However, in comparison to administrative personnel and construction engineers in the B group, construction engineers in the T group experienced the greatest energy deficit (-950 kcal/day). Mean nutrient intakes of the T group did not meet the Military Recommended Dietary Allowances for energy, folate, magnesium, and zinc and also did not achieve the dietary recommendations for carbohydrate and dietary fiber. Relative to the B group, the T group consumed significantly less energy, carbohydrate, protein, dietary fiber, vitamin A, folate, thiamin, vitamin C, magnesium, and phosphorus. T Ration entrees were initially acceptable, but their ratings declined to dislike after repeated exposure. When volunteers were asked what they would recommend to the Commandant of the Marine Corps about feeding policy, 31% stated that troop morale would suffer if Marines were to rely on T Rations for field feeding. Prolonged feeding of T Rations in the manner they were served on this study cannot be advocated. With modification of the T Ration menu and enforcement of enrichment policies, the ration may prove to be adequate for Marines during extended deployment.

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T Rations, B Rations, Ration Sustainment, Extended Operations, Ration Enhancement

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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research.

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LIST OF ACRONYMS AND ABBREVIATIONS

^2H_2O	deuterated water, stable heavy water isotope
$^2H_2{}^{18}O$	oxygen-18 water, stable heavy water isotope
°C	degrees Celsius
%RH	percent relative humidity
A Ration	full service ration received in the mess hall or galley
A/D	analog-to-digital
Admin	administrative
ALCO	alcohol
AMSC	Army Medical Service Corps
ANCOVA	analysis of co-variance
ANOVA	analysis of variance
AR	Army Regulation
B Ration	field ration consisting of canned, dehydrated and dry ingredients
BMI	body mass index
C	Celsius
CFFS	Combat Field Feeding System
CHO	carbohydrate
CMNR	Committee on Military Nutrition Research
CP	chemical protective
DLW	doubly labeled water
DoD	Department of Defense
DSCP	Defense Supply Center Philadelphia
F	Fahrenheit
FAT	fat
FY	fiscal year
g	gram
GI	gastrointestinal
Ht	Height
hrs	hours

kcal	kilocalorie
kg	kilogram
L/Day	liters per day
m	meters
MANOVA	multivariate analysis of variance
mg	milligram
μg	microgram
MiDAS	Military Dietary Assessment System
min	minute
m/sec	meters per second
mph	miles per hour
MRDA	Military Recommended Dietary Allowance
MRE	Meal, Ready-to-Eat
n	number of volunteers in sample
na	not available/applicable
NSOR	Nutritional Standard for Operational Rations
NRDEC	Natick Research, Development, and Engineering Center
OTSG	Office of the Army Surgeon General
PBRC	Pennington Biomedical Research Center
Pogey Bait	personal food brought or bought for consumption while in the field
POMS	Profile of Mood States
PRO	protein
RBDF	Royal Bahamian Defence Force
RE	Retinol Equivalent: 1 retinol equivalent = 1 μg retinol or 6 μg β-carotene
RH	relative humidity
RLW	Ration Light Weight
S.D.	standard deviation
SF	Special Forces
SFA	saturated fatty acids
SFAS	Special Forces Assessment and Selection Course
SPSS	Statistical Package for the Social Sciences
SSC	Soldier Systems Command
T1	baseline and first field test period

T2	mid-point field test period
T3	end-point field test period
T Ration	Tray Ration
TBW	total body water
TDEE	total daily energy expenditure
TE	Tocopherol Equivalent : 1 mg of α-tocopherol = 1αTE
TMD	total mood disturbance
TSLP	total sleep hours
UGR	Unitized Group Ration
USANRDEC	United States Army Natick, Research, Development, and Engineering Center
USACDEC	United States Army Combat Developments Experimentation Center
USARIEM	United States Army Research Institute of Environmental Medicine
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
USG	urine specific gravity
USMC	United States Marine Corps
VAA	Volunteer Agreement Affidavit
W	Watts
W/m^2	Watts per meter squared
Wk	Week
Wt	Weight

EXECUTIVE SUMMARY

This study evaluated the effectiveness of the Tray Pack Ration (T Ration) system to adequately sustain Marines, without causing excessive weight loss and/or gastrointestinal (GI) symptoms, during a 60-day Marine construction mission. The findings regarding the effectiveness of the T Ration, and to some extent the B Ration, reflect the ration as actually used, not as theoretically planned. Therefore, this study was a valid and representative measure of the T Ration system as it often functions and the problems that may affect consumption and nutrient intakes. These problems include, but were not limited to: lack of vegetable and fruit enhancements at most meals, unavailability of some menu items, hot storage conditions, poor food presentation, and an overworked mess staff. Volunteers (n=85) were randomly assigned to receive either 2 T Ration meals (breakfast and dinner) and 1 Meal, Ready-to-Eat (MRE) (T group), or 2 B Ration meals and 1 MRE (B group). Volunteers (n=19) in the T group (all with a rank of E-4 or below), but none in the B group, dropped for food-related reasons. Seventeen volunteers in the T group and 34 in the B group finished the study and remained in their assigned group. Neither group reported GI symptoms. The type of ration did not affect sleep, mood or physical performance. Weight loss, which did not significantly differ between ration groups, exceeded the 3% criterion by Day 56. Mean energy expenditure was 3328 ± 637 kcal/day. Both groups were in negative energy balance. However, in comparison to administrative personnel and construction engineers in the B group, construction engineers in the T group experienced the greatest energy deficit (-950 kcal/day). Total energy intakes were significantly lower in the T group than in the B group and decline over time; from 2702 ± 480 to 2580 ± 554 to 2423 ± 445 kcal/ day for the T group over the three study periods and from 3094 ± 556 to 2822 ± 658 to 2687 ± 647 kcal/day in the B group. Mean nutrient intakes of the T group did not meet the Military Recommended Dietary Allowances for energy, folate, magnesium, and zinc, and also did not reach the dietary recommendations for carbohydrate and fiber. T Ration entrees were initially acceptable, but their ratings declined to dislike after repeated exposure. When volunteers were asked what they would recommend to the Commandant of the Marine Corps about feeding policy, 31% stated that troop morale would suffer if Marines were to rely on T Rations for field feeding. Modification of the T Ration menu and enforcement of enrichment policies are necessary if the T Ration is to be considered for Marines during extended deployments.

CHAPTER 1

BACKGROUND AND STUDY DESIGN

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INTRODUCTION

Military Relevance

The proposed go-to-war ration for the U.S. Marines is the Tray Pack Ration (T Ration). Operational requirements suggest that Marines may need to consume T Rations for up to 9 months. The Commandant of the United States Marine Corps (USMC) in a tasking letter to COL Richard Lynch, AMSC (1) requested the Office of the Army Surgeon General (OTSG), as the Department of Defense (DoD) Executive Agent for Nutrition, to develop a T Ration feeding policy that would specify the duration that T Rations can be fed as the primary ration. The USMC were concerned about anecdotal reports of diarrhea and weight loss after lengthy consumption of T Rations. The OTSG needed data upon which to set a policy statement. The most recent study testing the T Ration was a 10-day study by Kramer et al. (5). Slight changes in the T Ration menu have been made since that study. Tharion et al. (8) completed a study of the Unitized Group Ration (UGR) which was a mixture of A, B and the current T Ration components for 10 days.

Background

Operational rations are designed for use in field situations. They are considered to be nutritionally adequate for groups of military personnel if all components of the ration are consumed (9,11). Nutritional adequacy is based on the provision of energy and 20 nutrients at levels stipulated by the Nutritional Standards for Operational and

Restricted Rations (2). The adequacy of operational rations for the remaining 20 or so essential nutrients cannot be assumed. In addition, it cannot be assumed that because ration provision is adequate for a group, all individuals will meet their individual needs. Underconsumption of rations is a common problem which, if persistent over an extended time, can lead to decrements in morale, as well as in physical and cognitive performance (6).

Monotony caused by repeated exposure to the same menu cycle may exacerbate the problem of underconsumption (3). Consumption of even highly rated items may decline over time. The T Rations are comprised of ten breakfast and ten dinner menus, with a complete description published previously (10). One Meal Ready-to-Eat (MRE) is typically provided for the third meal of the day. Such a limited range of foods and menus may soon become boring. Since Marines are likely to use T Rations for extended periods of time, they should be field tested under conditions that are likely to be prevalent during combat operations (i.e., for extended periods of time) to determine the health and performance effects of such use. As Thomas et al. (9) have observed, a ration that is nutritionally adequate is not enough. Marines and other war-fighters must be willing to eat the prescribed amounts of the ration even under harsh conditions. The ration must be capable of providing the metabolic requirements for the work at hand, whether they be combat or combat support activities, and physical performance and psychological state of the individual must not be compromised as a result of eating the ration.

The T Ration was extensively tested during a field exercise in 1985 at the Pohakuloa Training Area in Hawaii, Combat Field Feeding System (CFFS) study (11). During that field study, the ration provision for one test group was two T Rations plus one MRE. Energy intakes averaged 2721 kcal/day, which did not meet the Military Recommended Dietary Allowance (MRDA) for energy of 3200 kcal for the moderately active soldier (2). The low energy intakes were attributed to the lack of consumption of the T Ration spreads (e.g., cheese, peanut butter, and jelly) and many of the breakfast items. The T Ration Menu was redesigned based on the results of the CFFS study and re-evaluated (4,7) based on measures of nutrient intake, ration acceptability, body weight and body fat changes, hydration status, energy expenditures, and psychological assessment. Further improvements were made in the T Ration and were evaluated by

Kramer et al. (5).

Although there are no data to indicate that prolonged feeding of T Rations is unhealthy, there are no data to support an assumption that prolonged feeding of T Rations is without consequence. No study examined using only T Rations and MREs in the field for a period exceeding 36 days (11). This study examined the continued use of two T Ration meals and one MRE meal per day vs. two B Ration meals and one MRE meal per day (i.e., the meal system currently used by USMC) for a period of 60 days.

STUDY PURPOSE

The purpose of this test was to assess the effectiveness of the T Ration in meeting the nutritional requirements of combat support troops participating in a field construction mission in a warm to hot environment.

STUDY DESIGN

Subjects

Volunteers of this study were members of the 8th Engineer Support Battalion based at Camp Lejeune, NC, where baseline testing took place. The field portion of this study was conducted on Great Inagua in the Bahama Islands chain during the months of April and May 1998. USMC field feeding doctrine was followed. Testing was incorporated into the normal construction mission that was taking place.

Volunteers were briefed on the purpose of the study and the risks and benefits involved. Before beginning the study, volunteers completed a Volunteer Agreement Affidavit and a Background Questionnaire. Of the 90 Marines who were briefed on the study, 85 (which included 5 female Marine volunteers) completed volunteer agreement forms. The number of volunteers completing the various data collection efforts differs because 1) some volunteers agreed to participate in only certain parts of the study; 2) some volunteers dropped from the study— the most common reason being dissatisfaction with the ration group to which they had been randomly assigned; and 3) because of the expense of doubly labeled water (DLW), only a small, but statistically adequate sub-sample of volunteers provided energy expenditure data.

General Study Design

The experimental test period occurred during a 60-day construction mission by the Marines on Great Inagua Island in the Bahamas. There were two experimental groups: the test group received a T Ration meal for breakfast and dinner, while the control group received B Rations for those same meals. Volunteers were grouped by job speciality and then randomly assigned to either the T or B Ration group. Job grouping was done prior to the random assignment to ensure equal number of volunteers with heavy physical jobs vs. supervisory or office jobs in each group. Both groups received an MRE for lunch. An outline of the testing schedule is shown in Table 1.1. Baseline measurements (T1) began at Camp Lejeune and continued for the first 10 days of deployment in the Bahamas. Mid-test measurements (T2) and final measurements (T3) took place while deployed in the Bahamas. During T1, the following measurements were done: the Background Questionnaire, pre-deployment physical activity survey, anthropometric measures, total daily energy expenditure (TDEE) using the DLW method, activity monitoring, and mood assessment using the Profile of Mood States (POMS) questionnaire, gastrointestinal (GI) symptoms using a questionnaire, physical performance measures (bench press, arm curl and vertical jump tests), 6-day dietary intakes, ration acceptance, and daily urine concentrations on the DLW group. The second test period (T2) occurred 32 days after deployment to the field (Days 33-38). During T2, the following assessments took place: field anthropometric measures, 6-day dietary intakes, ration acceptance, TDEE using the DLW method, urine concentrations, activity monitoring, physical performance, and mood state. Final assessments (T3) occurred the last week in the field. During T3, the same measures as during T2 were taken as well as an exercise survey and an end-of-study ration survey. Throughout the study, GI symptoms and body weights were assessed once a week. Weather data were recorded throughout to maintain a record of environmental conditions.

TABLE 1.1 Timeline of tests.

	T1								
Baseline	**Day 0**	**Day 1 †**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**
March 16-18	March 30	March 31	April 1	April 2	April 3	April 4	April 5	April 6	April 7
	Urine	x	x	x	x	x	x	x	x
	DLW Dose								
		Activity Monitor	x	x	x	x	x	x	
						Dietary Intake/ Ration Acceptance	x	x	x
VAA									
Demographics									
POMS						POMS		POMS	
Exercise Survey									
Circumferences									
Height									
Weight*								Weight	
GI#					GI				
Bench Press									
Arm Curl									
Vertical Jump									

† Deployment Day

* Body Weight Measures After Baseline Were Also Obtained on the Following Dates: April 13,20,27; May 11,18

GI Questionnaires After Baseline Were Also Administered on Following Dates: April 10, 17, 24; May 1, 15, 22

TABLE 1.1 (Continued). Timeline of Tests.

T1		T2						
Day 9	**Day 10**	**Day 33**	**Day 34**	**Day 35**	**Day 36**	**Day 37**	**Day 38**	**Day 39**
April 8	April 9	May 2	May 3	May 4	May 5	May 6	May 7	May 8
Urine -------------------------------------x		Urine ------------------x-------------x-----------x---------------x------------------x------------x						
		DLW Dose						
		Activity Monitor --------x-------------x-----------x---------------x------------------x						
Dietary Intake/ Ration Acceptance----------------------x		Dietary Intake/ Ration Acceptance ------x-------------x-----------x---------------x------------------x						
POMS		POMS		POMS		POMS		
Circumferences		Circumferences						
Weight				Weight				
								GI
Bench Press		Bench Press						
Arm Curl		Arm Curl						
Vertical Jump		Vertical Jump						

TABLE 1.1 (Continued). Timeline of Tests.

T3						
Day 54	**Day 55**	**Day 56**	**Day 57**	**Day 58**	**Day 59**	**Day 60**
May 23	May 24	May 25	May 26	May 27	May 28	May 29
Urine	x	x	x	x	x	x
DLW Dose						
Activity Monitor	x	x	x	x		
Dietary Intake/ Ration Acceptance	x	x	x	x	x	
						Post-Test Ration Survey
POMS		POMS		POMS		
						Exercise Survey
Circumferences						
Weight					Weight	
						GI
Bench Press						
Arm Curl						
Vertical Jump						

Rations

The T Ration is a heat-and-serve ration that does not require refrigerated storage and has a shelf life of 3 years. The T Ration items are packed in rectangular, metal containers that serve as protective packages, heating pans, and serving trays. These rations allow for reductions in personnel (i.e., cooks), equipment (e.g., stoves) and water (preparation and cleanup) vs. using B Rations. The current T Ration consists of a 10-day menu cycle with 10 breakfast and 10 dinner menus. An MRE is provided as the lunch meal of the day. A T Ration meal includes an entree, a starch, a vegetable, a dessert, instant beverages plus supplemental bread and aseptically-packaged milk. A T Ration meal, including the required milk and bread supplements, provides an average of 1420 kcal (approximately 16% protein, 29% fat, and 55% carbohydrate) (10).

The B Ration[1] consists of canned and dehydrated foods that do not require refrigeration, but do require kitchen facilities and trained food service personnel. The complete B Ration system is also a 10-day menu cycle, with menus and recipes for 10 breakfasts and 10 dinners. Because of differences in B and T Ration menus a greater variety of foods were offered to volunteers in the B Ration Groups. B Rations supply 1430 kcal/meal (13% protein, 33% fat, and 54% carbohydrate)(10). The T and B Rations were supplemented, to a small extent, with fresh produce (i.e., fresh fruit and salads).

OBJECTIVES

A number of objectives were set for this study to assess the effectiveness of the T Ration in meeting the nutritional requirements of Marines, as well as maintaining their health and performance. The following were objectives set prior to data collection.

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[1]The Marine unit had intended on providing mostly B Rations, with some Tray Ration items on this deployment. In order to accommodate the needs of this study, the unit agreed to provide B Rations to half of the unit and T Rations to the other half. This allowed individuals assigned to the B Ration test group to act as controls for those in the T Ration group.

1. To compare the effectiveness of Marines consuming two T Rations and one MRE per day vs. those consuming two B Rations and one MRE per day for 60 days in meeting one's nutritional needs.

2. To determine whether Marines subsisting on two T Rations and one MRE per day for 60 days can maintain body weight and lean body mass.

3. To determine whether Marines subsisting on two T Rations and one MRE per day for 60 days have any more GI distress than those consuming two B Rations and one MRE per day.

4. To determine whether dietary intakes of Marines subsisting on T Rations for 60 days are adequate to meet energy and nutrient requirements.

5. To determine whether acceptance of T Rations consumed by Marines for 60 days declines over time.

6. To determine whether energy expenditures by Marines subsisting on T Rations for 60 days are maintained over time.

7. To determine whether physical performance and/or mood is negatively affected in Marines subsisting on T Rations for 60 days.

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CHAPTER 2

DEMOGRAPHICS AND ENVIRONMENTAL CONDITIONS

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INTRODUCTION

Combat support engineers are deployed frequently both in and out of the United States to complete building or demolition projects. As a unit they are frequently exposed to a variety of different environments. Various temperatures, availability of local food and water, ration quality and length of the mission are but a few of the factors that impact the health and performance of Marines during these deployments. Previous research showed that older soldiers and those with more than 2 years active duty were less likely to drop from a field study because of the stresses involved in an equipment decontamination operation while donned in chemical protective equipment (1). While there are no detailed results regarding adherence to eating specific rations, it is reasonable to suspect that like the above study's findings, seasoned soldiers or Marines that have more experience in the field are less likely to experience stress and are better able to tolerate field rations than their more youthful cohorts. However, it might also be expected that experienced military personnel would be more critical of changes in the system, such as moving from B Rations to Tray Pack Rations (T Rations), because they were used to the B Rations. B and T Rations have been described previously (7).

This chapter describes the volunteer sample with regard to various demographic characteristics and recent background experience with field rations. While this study was not tested under drastically changing environmental conditions, it was conducted under warm to hot conditions as existent in the Caribbean area during the months of April and May. Changes in environmental conditions often change nutritional, clothing and work requirements (2,3,4). While the results of this study do have general applications, the environmental conditions should be kept in mind. For example, fluid requirements are likely to be higher for these work conditions than if working similarly in the winter months in the northern United States. In contrast, working similarly in the southwestern United States desert regions during the summer may necessitate higher fluid intakes due to high temperatures and low humidities which induce high rates of evaporative sweat loss.

METHODS

Study Volunteers

Data in this chapter are for those volunteers who provided data during all three test periods. There were no statistical differences between those who completed the study vs. those who did not.

Background Questionnaire

Demographic and background information was obtained by administering a 14-item optically scanned questionnaire at T1 (during baseline testing at Camp Lejeune). This questionnaire provided demographic information and identified field meal patterns. Demographic questions included age, gender, ethnic background, rank, and job title. Other questions focused on field living such as amount of time spent in the field in the past year, weight gain or loss when in the field, and eating habits in the field including consumption of personal food.

Environmental Conditions

Meteorological data were collected using an automated portable weather station which utilized the Campbell CR10 Measurement and Control Module (Campbell Scientific, Inc., Logan, UT). This battery-operated system collected the following measures: air temperature, ground temperature, relative humidity, global radiation, wind speed and black globe temperature. All measures were obtained every 15 min for the length of the study, as done previously (6).

Air and Ground Temperatures. Ground temperature was obtained by burying a thermistor probe approximately 2 cm under the surface in the loose, sandy soil. This ground cover was representative of the testing region. Air temperature was measured by a thermistor sensor in a temperature-humidity probe (HMP35, Vaisala, Inc., Helsinki, Finland). The probe was housed in a radiation shield mounted at 1.5 m on the weather station tripod. Temperature was measured in degrees Celsius (°C).

Relative Humidity. Relative humidity refers to the moisture content in the air with respect to the saturated water vapor pressure (5). The Vaisala temperature-humidity probe described above utilized an electronic capacitance sensor to determine relative humidity. Relative humidity measurements are expressed as the ratio of the actual water content of the air to the maximum potential for saturated air as a percentage.

Global Radiation. Global solar radiation measures all solar energy that reaches a horizontal surface either as a direct beam, or as diffuse sunlight that is initially deflected by the atmosphere before reaching the surface. Global radiation was measured with a pyranometer (LI200X, Campbell Scientific Inc, Logan, UT). The pyranometer was mounted 1.5 m above the ground on an arm perpendicular to the weather station tripod and positioned to the south so that the pyranometer was not shaded by the other weather instruments or any surrounding vegetation. Radiation was expressed as a flux density, the rate of energy received per unit area in Watts per meter^2 (W/m^2) (5).

Wind Speed. A three cup anemometer (Model 03001-5, R.M. Young Co., Traverse City, MI) was used to measure wind speed. The anemometer was secured to the top of the tripod 2 m above the ground. Wind speeds are presented in meters per sec (m/sec) and miles per hour (mph).

Black Globe Temperature. A thermistor probe was inserted inside a metal 15 cm diameter black globe thermometer mounted 1.5 m above the ground on an arm perpendicular to the weather station tripod. The black globe thermometer assesses the combined effects of air temperature and solar radiation (5). Temperature was measured in °C.

Statistical Analyses

Results for ratio data were analyzed for statistical significance between the two diet groups by analyses of variance and t-tests. Chi-square analyses examined differences in frequency data between various group categories. Statistical significance was set at $p \leq 0.05$ for all tests. Descriptive statistics are presented as means ± standard deviations. Frequency counts and percentages are presented for non-ratio data. Maximum and minimum measures are given for daily ambient temperatures.

RESULTS

Volunteer Drops

During the study, 28 of the 85 volunteers dropped from the study. A chi-square analysis of those who dropped because of the food vs. those not dropping for food reasons revealed a significant ($p < 0.001$) difference by ration group (19 T Ration volunteer drops, 0 B Ration volunteer drops). In addition, all 19 of the T Ration drops had an E-4 rank or below ($p < 0.001$). A total of 63 volunteers had ranks of E-4 or below, while 22 had ranks of E-5 or above. Table 2.1 summarizes volunteer drops by ration group and reason for the drop. Included in the "Drops Because of the Food" are two Week 1 drops who continued with the study as B Ration volunteers.

Demographic Information

The demographic information for the 59 volunteers who completed the study are reported in Table 2.2. The combined mean age is 24.0 ± 5.1 yrs. A model representative of the group as a whole would be a 24-year-old white male (there were 5 females) with a rank of E-3. One officer was in the B-ration group with a rank of O-3, and three officers of O-2 rank were in the T-ration group. No significant differences in any demographic characteristics existed between ration groups.

Field Feedings

Information regarding past field experience is contained in Table 2.3. As a group, the rations most typically eaten in the field were the Meal Ready-to-Eat (MRE) (74.6%) followed by B Rations (13.6%). Only 5.7% of the Marines reported eating T Rations at all prior to this exercise. When it came to personal choices for the type of pogey bait taken to the field in the past (Table 2.4), only Ramen Noodles were significantly different between the two groups ($p \leq 0.04$). This item was not documented as consumed on this study (See Chapter 5). Meat jerky was the main pogey bait item that has been brought into the field (47.5%). Other types of foods brought to the field were candy, nuts, and breakfast bars. These are all items that can be carried easily in pockets or in one's pack and are easy to consume while on a mission. The most common drinks that have been brought to the field in the past were soft drinks followed by sports drinks.

Environmental Conditions

Testing was completed in tropical conditions with test sites relatively unshaded with sandy-rocky soil. Rainfall was not recorded. There were a few heavy showers, but they usually lasted less than 30 mins. Water for drinking and general use was de-salinated from ocean water pumped 800 m to the base camp. Mosquitos and sand flies were persistent problems for volunteers and researchers throughout the course of the study.

Table 2.1. Frequency of volunteer drops by ration type (B vs. T Ration)[1] over time.

Group and Drop Reason	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	TOTAL
B (Because of the Food)	0	0	0	0	0	0	0	0	0	0
T (Because of the Food)	2	2	8	3	0	0	2	2	0	19
B (Administrative)	0	1	0	0	0	1	0	0	0	2
T (Administrative)	0	0	0	0	0	0	2	0	0	2
B (Voluntary Not Food)	1	2[2]	0	0	0	0	0	0	0	3
T (Voluntary Not Food)	1	0	0	0	0	0	0	0	0	1
B (Medical Not Food)	0	1	0	0	0	0	0	0	0	1
T (Medical Not Food)	0	0	0	0	0	0	0	0	0	0

[1] B Ration Group began with $n = 42$ and the T Ration Group began with $n = 43$ assigned. Two T Ration volunteers who dropped immediately upon being deployed because they would not eat the T Rations were allowed to switch to B Rations and continue with the study.

[2] A volunteer in the B Ration Group would not complete questionnaire data (i.e., he is considered one of the two voluntary drops in Week 2). He agreed to eat only B Rations and participate in physical performance assessments and anthropometric assessments, hence his data are used in those portions of the study.

[3] Seven additional volunteers "cheated" (ate B Rations in small amounts, less than 5 meals) and this was documented. Their data were included, hence they are not considered drops in this table.

[4] Final number of volunteers to complete the study; B Ration: $n = 38$; T Ration: $n = 21$.

Table 2.2. Demographics.

Age Group	***n***	**Percentage**
0 thru 29	52	(88.1%)
30 thru 39	6	(10.2%)
40 thru highest	1	(1.7%)
Rank	***n***	**Percentage**
E1 - E3	29	(49.1%)
E4 - E6	23	(39.0%)
E7 - E8	3	(5.1%)
O1 - O3	4	(6.8%)
Ethnic Group	***n***	**Percentage**
White (not Hispanic)	45	(76.3%)
African-American	7	(11.9%)
Hispanic	3	(5.1%)
Other	4	(6.8%)
Ration Group	***n***	**Percentage**
B Ration	37	(62.7%)
T Ration	22	(37.3%)
Gender	***n***	**Percentage**
Men	56	(94.9%)
Women	3	(5.1%)

Table 2.3. Prior field deployment experience in the past year.

Time spent in the field	*n*	Percentage
None	6	(10.2%)
Less than 1 time or week	2	(3.4%)
1 week to 1 month	17	(28.8%)
> 1 month < 3 months	13	(22.0%)
3 months or more	21	(35.6%)
Ration most eaten in the field	***n***	**Percentage**
A Ration	2	(3.4%)
B Ration	8	(13.6%)
T Ration	2	(3.4%)
MRE	44	(74.6%)
Number of meals consumed per day in the field	***n***	**Percentage**
One	2	(3.6%)
Two	19	(33.9%)
Three	27	(48.2%)
Four or more	8	(14.3%)
Rations meet your nutritional needs	***n***	**Percentage**
Yes	46	(78.0%)
No	13	(22.0%)

Table 2.3 (Continued). Prior field deployment experience in the past year.

Type of rations eaten for breakfast during field exercises	*n*	Percentage
A Ration	7	(13.0%)
B Ration	10	(18.5%)
T Ration	2	(3.7%)
MRE	35	(64.8%)
Type of rations eaten for lunch during field exercises	***n***	**Percentage**
A Ration	0	(0.0%)
B Ration	4	(7.3%)
T Ration	0	(0.0%)
MRE	51	(92.7%)
Type of rations eaten for dinner during field exercises	***n***	**Percentage**
A Ration	4	(7.5%)
B Ration	13	(24.5%)
T Ration	3	(5.7%)
MRE	33	(62.3%)
What happens to your weight in the field	***n***	**Percentage**
Lose Weight	23	(41.1%)
Gain Weight	6	(10.7%)
Neither	27	(48.2%)
Do you use the field to lose weight	***n***	**Percentage**
Never	42	(75.0%)
Sometimes	13	(23.2%)
Always	1	(1.8%)

Table 2.4. Pogey bait.

FOOD	*n*	Percentage
Meat Jerky	28	(47.5%)
Nuts	19	(32.2%)
Candy	17	(28.8%)
Breakfast Bars	16	(27.1%)
Soft Drinks	13	(22.0%)
Tuna Fish	11	(18.6%)
Sport Drinks	10	(16.9%)
None	9	(15.3%)
Pop Tarts	8	(13.6%)
Cookies	7	(11.9%)
Fruit	7	(11.9%)
Ramen Noodles	6	(10.2%)
Chips	6	(10.2%)
Bottle Water	5	(8.5%)
Crackers	4	(6.8%)
Power Bars	3	(5.1%)
Soups	2	(3.4%)
Stews	2	(3.4%)
Snack Pudding	2	(3.4%)
Peanut Butter	2	(3.4%)
Canned Nourishments	1	(1.7%)
Other - Clams	1	(1.7%)
Other - Sardines	1	(1.7%)

Air and Ground Temperatures. Air and ground temperatures followed a diurnal pattern of increasing during the day and decreasing at night. Daytime (0600-1900 hrs) air temperature averaged 28.0° ± 2.1°C, while nighttime air temperature (1900-0600 hrs) averaged 24.5° ± 1.5°C. Daily high and low air temperatures with associated percent relative humidity are shown in Table 2.5. Daytime ground temperature averaged 29.8° ± 5.2°C, while nighttime ground temperature averaged 23.4° ± 2.1°C. The mean air temperature for the study was 26.4° ± 2.5°C, while the mean ground temperature was 26.9° ± 5.2°C.

Relative Humidity. Relative humidities were highest during the early morning hours and lowest during the mid-afternoon. Daytime relative humidity averaged 64.1% ± 10.5%, while nighttime relative humidity averaged 77.4% ± 10.0%. Overall relative humidity ranged from 35.5% to 100.0% with a mean value of 70.1% ± 12.2%.

Global Radiation. Global radiation fluctuated over the study based on cloud cover. Overall, it was relatively high with noon-time values exceeding 1000 W/m^2. Overall global radiation averaged 474 ± 328 W/m^2 during daytime hours (0600 - 1900 hrs) with a range from 0 to 1289 W/m^2.

Wind Speed. Wind was minimal during this study, 2.5 ± 1.4 m/sec (5.5 ± 3.1 mph). Wind speeds ranged from 0.2 to 6.7 m/sec (0.4 to 14.9 mph).

Black Globe Temperature. Daytime black globe temperatures were high, averaging 35.5° ± 6.0°C with a range of 19.6° to 53.8°C.

Table 2.5. High and low daily temperatures in degrees Celsius (°C) with associated percent relative humidities (RH).

WEEK 1					4/3 FRI	4/4 SAT	4/5 SUN
HI (%RH) LO (%RH)					29.0 (54.2)	29.2 (63.5) 20.7 (87.7)	29.8 (70.3) 23.6 (83.9)
WEEK 2	4/6 MON	4/7 TUE	4/8 WED	4/9 THUR	4/10 FRI	4/11 SAT	4/12 SUN
HI (%RH) LO (%RH)	29.4 (65.1) 22.6 (85.6)	29.5 (51.2) 20.4 (90.6)	28.9 (57.8) 23.0 (77.0)	29.6 (64.1) 24.2 (82.4)	30.8 (55.0) 23.5 (92.0)	31.2 (64.3) 23.4 (90.2)	27.1 (48.7) 22.2 (57.8)
WEEK 3	4/13 MON	4/14 TUE	4/15 WED	4/16 THUR	4/17 FRI	4/18 SAT	4/19 SUN
HI (%RH) LO (%RH)	26.1 (40.5) 21.5 (48.1)	27.2 (38.9) 20.8 (55.8)	28.0 (42.7) 21.6 (70.1)	28.3 (40.7) 22.2 (67.8)	29.5 (52.9) 22.3 (69.3)	29.6 (44.0) 22.2 (80.9)	29.1 (58.3) 23.1 (79.9)
WEEK 4	4/20 MON	4/21 TUE	4/22 WED	4/23 THUR	4/24 FRI	4/25 SAT	4/26 SUN
HI (%RH) LO (%RH)	29.8 (57.5) 23.0 (85.4)	30.2 (57.1) 22.9 (88.0)	30.0 (63.7) 22.1 (89.9)	30.9 (48.4) 23.8 (89.0)	28.5 (62.9) 24.3 (86.3)	28.2 (47.6) 24.0 (59.5)	28.6 (57.9) 23.8 (70.6)
WEEK 5	4/27 MON	4/28 TUE	4/29 WED	4/30 THUR	5/1 FRI	5/2 SAT	5/3 SUN
HI (%RH) LO (%RH)	30.2 (59.0) 23.5 (89.4)	30.5 (58.2) 24.6 (81.8)	30.5 (57.4) 24.8 (82.9)	29.7 (54.7) 23.8 (78.4)	31.7 (39.6) 22.2 (76.2)	31.9 (59.0) 22.4 (93.6)	31.6 (56.0) 24.3 (86.9)

Table 2.5 (Continued). High and low daily temperature in degrees Celsius with associated percent relative humidities (RH).

WEEK 6	5/4 MON	5/5 TUE	5/6 WED	5/7 THUR	5/8 FRI	5/9 SAT	5/10 SUN
HI (%RH) LO (%RH)	29.9 (62.5) 22.6 (91.1)	30.4 (59.0) 22.2 (93.1)	31.8 (47.3) 23.3 (93.0)	30.1 (64.3) 24.1 (86.5)	30.3 (53.5) 22.2 (82.2)	31.4 (53.1) 21.5 (90.4)	30.8 (60.6) 21.6 (84.6)
WEEK 7	5/11 MON	5/12 TUE	5/13 WED	5/14 THUR	5/15 FRI	5/16 SAT	5/17 SUN
HI (%RH) LO (%RH)	31.9 (57.1) 24.8 (89.0)	31.1 (65.2) 26.5 (80.4)	31.4 (68.9) 24.8 (84.6)	31.0 (51.1) 19.9 (82.8)	30.5 (54.5) 23.1 (75.5)	30.2 (48.0) 19.2 (79.5)	30.6 (36.9) 23.0 (73.8)
WEEK 8	5/18 MON	5/19 TUE	5/20 WED	5/21 THUR	5/22 FRI	5/23 SAT	5/24 SUN
HI (%RH) LO (%RH)	30.0 (49.9) 23.5 (73.2)	30.9 (57.2) 22.9 (80.0)	31.2 (44.9) 23.4 (87.5)	31.1 (51.9) 23.1 (85.6)	30.4 (62.5) 23.9 (81.7)	31.7 (58.7) 24.8 (89.7)	31.4 (60.2) 26.2 (85.9)
WEEK 9	5/25 MON	5/26 TUE	5/27 WED	5/28 THUR			
HI (%RH) LO (%RH)	32.1 (57.1) 26.3 (71.0)	31.4 (54.9) 25.1 (79.4)	32.7 (56.7) 26.8 (85.4)	29.2 (68.8) 27.1 (80.1)			

DISCUSSION

Environmental conditions were typical for the late spring on this southern-most island of the Bahama Islands chain. High relative humidities and high solar loads during the middle part of the day led to some hydration problems that will be discussed in Chapter 6. Because of high solar radiation during the middle of the day, sunburns were a continuous problem despite warnings from the command staff to wear sunscreen and protective clothing. Use of insect repellent, mosquito jackets and other protective clothing was necessary especially at dusk and dawn (meal times) to combat insect bites.

Similar to a previous study examining work in a simulated chemical warfare environment (1), those Marines with lower ranks were more likely to voluntarily drop from the study. Based on conversations with these Marines who dropped out, it is speculated the reason for dropping from the study was the combined stress of being deployed coupled with a low tolerance for their assigned field ration. It is likely that experience under field training conditions and/or combat will psychologically harden the Marine to be able to tolerate a ration that may be less desirable than home cooking. Coping strategies to deal with field environments, including the rations, are likely to have been developed through military experience and knowing what to expect when deployed. The stress of the food being less than desirable while deployed to an island in the Bahamas pales in nature to that stress some of these Marines have experienced in combat. For the younger Marine who may be on his first deployment, the stress experienced may have been perceived as much greater than that felt by his older Marine comrade with more time-in-service. This stress results from the physical labor of the work day, combined with the lack of home-cooked meals, the lack of having friends and family present, sleeping in relatively crowded non-private tents, and daily boredom. Choosing the food one eats likely reduces that stress somewhat, and it is one thing that could be under the individual's control if he/she were willing to drop from the study.

Regardless of the nature of the personal characteristics of those who voluntarily dropped from the study because of the food, it cannot be overlooked that all of those who dropped were in the T Ration group. There were no individuals in the B Ration group who decided they wanted to drop because they could not tolerate the B Ration food and wanted to move to the T Ration serving line. Part of the reason could be that

B Rations are what the Marines are used to. Their reported experience with T Rations in the field at the present time is very limited. Only 5.7% of the Marines in this sample reported eating T Rations, while 92.7% and 24.5% of the Marines had experienced MREs and B Rations, respectively. Furthermore, it could be suggested that through rumors and pre-conceived notions regarding T Rations that they perceived them to be inferior (see Chapter 10), hence those who dropped out were examples of a self-fulfilling prophecy. However, based on the ratings in the ration acceptability chapter (Chapter 5) and comments at the conclusion of the study regarding the rations (Chapter 10), it is most likely that these Marines actually disliked the T Rations more. While some felt they were losing weight because they were not eating enough, for the most part, the T Rations did not meet the taste expectations of the Marines as well as the B Rations did. Because participating in the study was secondary in importance to their mission of completing their building assignments, many Marines decided that it was not worth it to continue eating food they did not like when more palatable food was available. This behavior probably suggests that morale problems could develop if long-term use of T Rations as served on this study, were instituted as the standard USMC field ration.

CONCLUSIONS

- Volunteer Drops "Because of the Food" for T Rations out-numbered B Rations by a 19-0 margin. Marines who dropped cited reasons that they "did not like the food" and they were "losing weight" as reasons. It is likely that long-term use of T Rations as they are now constituted would cause morale problems.

- Volunteer Drops "Because of the Food" were all ranks of E-4 and below, suggesting these Marines may not be used to the stress of being deployed to the field and eating military rations to which they are unaccustomed.

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CHAPTER 3

BODY WEIGHT, BODY COMPOSITION, AND MEASURES OF GASTROINTESTINAL (GI) DISTRESS

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INTRODUCTION

One of the primary concerns the United States Marine Corps (USMC) has about using the Tray Pack Ration (T Ration) as its go-to-war ration is that anecdotal reports suggest there is excessive weight loss and gastrointestinal (GI) problems with prolonged consumption of these rations. In the most extensive study of T Rations to date, the Combat Field Feeding Study (CFFS) (10), the mean body weight loss of soldiers fed two T Rations meals and one Meal, Ready-to-Eat (MRE) per day for 36 days did not exceed 2%. In addition, there was no significant difference in GI symptomatology between soldiers consuming T Rations and other rations (combinations of A and B Rations and/or MREs).

The T Ration menu was redesigned based on the CFFS Study to provide more variety. Two other studies that evaluated the improved T Ration for 14-day periods reported average weight losses of 1.51% and 0.99% of initial body weights (7). A 10-day evaluation in the cold reported average weight losses of 1.10% (5). Activities in these studies varied. In the earlier studies (7), activities consisted of combat support tasks (e.g., resupply of ammunition and setting up of tents and camouflage) for the first group tested, and infantry training (e.g., road marches, firing range practice, and land navigation) for the second group tested. For the latter study (5), soldiers were involved in Arctic Warrior Field Training exercises. Further improvements in the T Ration were evaluated by Kramer et al. (6) with infantry soldiers undergoing 7 days of field training. Two groups of soldiers participating in identical military exercises received either a new T Ration or the old T Ration, which was the same ration used in the studies by Salter et al. (7). Weight loss associated with the new improved T Ration was only 0.5% compared to 1.2% of initial body weight for the older T Ration.

The major criterion of adequate ration consumption for the 1985 CFFS study and subsequent tests has been a body weight loss of no more than 3% of initial body weight. Based on the rates of weight loss observed during the CFFS study (10) and another 34-day study conducted by Hirsch et al. (3), the Office of the Army Surgeon General (OTSG) restricted the use of the MRE as the exclusive food source to no more than 10 days. With subsequent improvements to the MRE and a study by Thomas et al. (9), the limit for exclusive MRE use was extended to 21 days. The 21-day limit was based on the finding that after 21 days, average body weight losses exceeded 3% of initial body weight. There are insufficient data on groups subsisting on T Rations to determine at what time point their average body weight losses may exceed 3%. No study has examined the use of T Rations in the field for periods exceeding 36 days. Prior to our study, the longest assessment with the current T Ration (as part of the Unitized Group Ration) was 10 days (8). The current study examined body weight, body composition and GI changes with the continued consumption of two T Ration meals and one MRE meal per day for a period of 60 days.

METHODS

Baseline height and weight were taken at Camp Lejeune before deployment (See Table 1.1). Standing height was measured in stocking feet while standing on a flat surface, feet together, knees straight, and the head, shoulder blades, buttocks, and heels in contact with a vertical wall. Duplicate measurements were made to the nearest 0.1 cm using an anthropometer (Seritex, Inc., Carlstadt, NJ). Nude body weights were measured during baseline testing and weekly thereafter during the deployment. Body weights were taken at night to coincide with shower hours so that nude weights could be obtained. Body weight was measured using a calibrated electronic battery-powered scale (Seca, Birmingham, England) accurate to 0.1 kg. Body weight data are reported for the 60 volunteers (T Ration: n=21; B Ration: n=39) who had complete body weight data and remained in their assigned ration group.

Trained anthropometrists used the Army circumference technique to estimate percent body fat following the procedures outlined in AR 600-9 (1). Fiberglass anthropometric tapes (Gilick II, Country Technology, Inc., Gays Mills, WI) were used to measure circumferences of the neck at the level just below the larynx and of the abdomen at the midpoint of the navel. Each measure was repeated three times per test session by the same trained anthropometrist. Only males were measured; therefore, the three females participating in study who were in the B Ration group were not included (total sample: n = 57). Percent body fat was computed using the following equation:

% body fat = 46.892 - 68.678 X log height + 76.462 X log (abdomen - neck circumference).

A 13-item GI questionnaire was developed to assess symptomatology. A copy of this questionnaire is shown in Figure 3.1. The questionnaire was administered at baseline and thereafter by USMC medical personnel during the dinner meal every Friday of the deployment.

Statistical Analyses

Body weight, body composition, and GI symptoms results were analyzed for statistical significance between the two ration groups and over time using repeated measures analyses of variance (ANOVAs) with ration type as the grouping factor. Tukey's test was used to determine differences between weeks. Descriptive statistics are presented as means ± standard deviations. Statistical significance was set at $p \leq 0.05$.

Figure 3.1. Gastrointestinal (GI) Questionnaire.

Name ____________________ Subject Number __________ Date ____________

The following questions are about any stomach or intestinal feelings you may have experienced .

1. In the past **Week,** on what days did you experience the following?

	None	Fri	Sat	Sun	Mon	Tue	Wed	Thur
Cramps	○	○	○	○	○	○	○	○
Gas	○	○	○	○	○	○	○	○
Stomach Pain	○	○	○	○	○	○	○	○
Nausea	○	○	○	○	○	○	○	○
Vomiting	○	○	○	○	○	○	○	○
Heart Burn	○	○	○	○	○	○	○	○
Diarrhea	○	○	○	○	○	○	○	○
Loose Stools	○	○	○	○	○	○	○	○
Constipation	○	○	○	○	○	○	○	○
Poor Appetite	○	○	○	○	○	○	○	○
Bloating	○	○	○	○	○	○	○	○
Indigestion	○	○	○	○	○	○	○	○

2. Of symptoms listed please rate the intensity felt of that symptom on the following five point scale.

1. Slight 2. Somewhat 3. Moderate 4. Quite A Bit 5. Extreme

Symptom Listed	Fri/Rating	Sat/Rating	Sun/Rating	Mon/Rating	Tue/Rating	Wed/Rating	Thur/Rating
________	____	____	____	____	____	____	____
________	____	____	____	____	____	____	____
________	____	____	____	____	____	____	____
________	____	____	____	____	____	____	____
________	____	____	____	____	____	____	____
________	____	____	____	____	____	____	____

3. On average how many bowel movements did you have per day in the last Week ________.

RESULTS

Height

There were no differences between ration groups in standing height. Average height for all volunteers was 178 ± 7 cm.

Body Weight

Although ration type did not affect total body weight loss, a significant decrease ($p < 0.05$) in total body weight (Figure 3.2) as well as percent body weight loss for all volunteers (Table 3.1) was observed. Percent body weight loss did not differ between those T Ration volunteers who completed the study vs. those who dropped because they could not tolerate eating the food (Table 3.2). The column of drops by week, labeled "Percent Wt Change of Non-Finishers at Their Last Measurement," shows the weight loss or gain of volunteers along with the number of volunteers that dropped at that time. The column of cumulative drops labeled "Percent Wt Change of Non-Finishers Still Participating by Week" shows the weight of those volunteers who would eventually drop by week along with the number still left in the study at that particular weighing. In both drop cases the weighing was the last weighing done before the volunteer dropped from the study.

Average percent weight loss did not exceed 3% for either the T or B ration group for 49 days, but at 56 days weight loss exceeded 3% for both groups (See Table 3.1). A total of 29 or 48.3% of all volunteers exceeded the 3% weight loss upon completion of the deployment and, again, there were no differences in percentage of volunteers exceeding the 3% weight loss by ration group; T Ration: 47.6% vs. B Ration: 48.7%. A total of 19 or 31.7% of volunteers exceeded a 5% weight loss upon completion of the deployment. There were no differences in percentage of volunteers exceeding a 5% weight loss by ration group; T Ration: 33.3% vs. B Ration: 30.8%. Before the last week of the deployment, there were also no differences between ration groups in the percentage of volunteers whose weight loss exceeded either the 3% or 5% criterion. The percentage of total volunteers whose weight loss exceeded either the 3% or 5%

Figure 3.2. Body weight by ration group over time.

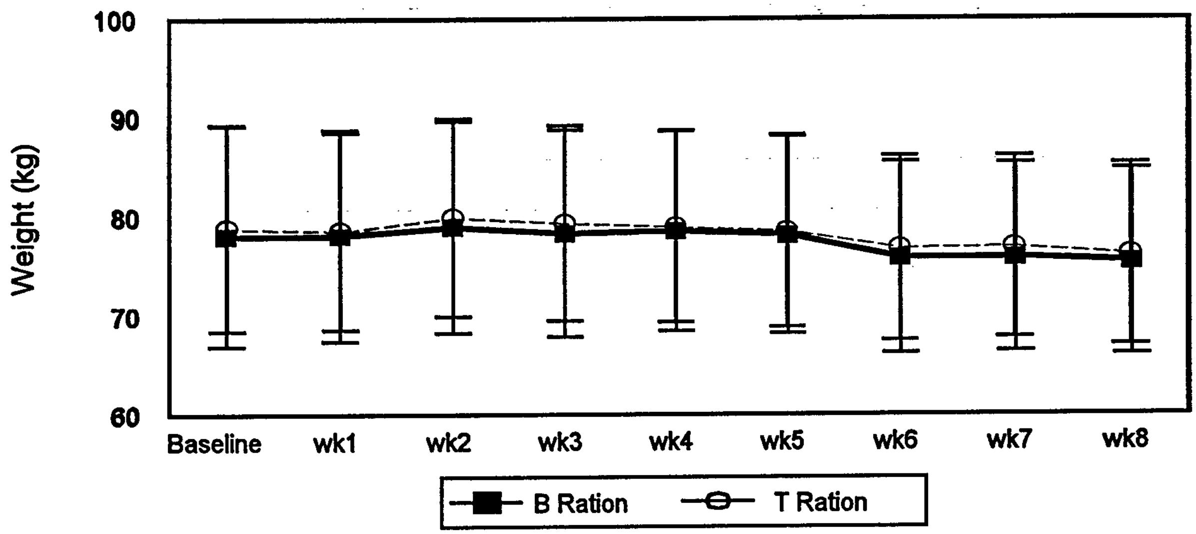


Table 3.1. Percent weight gain (+) or loss (-) from baseline by ration group over time.

	T Ration (*n*=21)	B Ration (*n*=39)	Total (*n*=60)
Week 1	-0.2 ± 2.0	+0.1 ± 1.6	0.0 ± 1.7
Week 2	+1.5 ± 2.1	+1.2 ± 2.6	+ 1.3 ± 2.4
Week 3	+0.7 ± 2.6	+0.4 ± 2.6	+0.5 ± 2.6
Week 4	+0.3 ± 3.0	+0.9 ± 2.9	+ 0.7 ± 2.9
Week 5	-0.2 ± 3.3	+0.3 ± 3.1	+0.1 ± 3.2
Week 6	-2.4 ± 3.6	-2.6 ± 3.2	-2.5 ± 3.3*
Week 7	-2.2 ± 3.9	-2.5 ± 3.4	-2.4 ± 3.5*
Week 8	-3.2 ± 4.0	- 3.1 ± 3.6	-3.1 ± 3.7*

* Values significantly different ($p < 0.05$) by week for all volunteers via Tukey's test.

Table 3.2. Percent weight gain (+) or loss (-) from baseline for T Ration volunteers who finished vs. those who dropped from the study.

	Percent Wt Change of Finishers by Week (*n*=21)	Percent Wt Change of Non-Finishers at Their Last Measurement#	Percent Wt Change of Non-Finishers Still Participating by Week * $
Week 1	-0.2 ± 2.0	-0.5 ± 1.6 (*n*=2)	+1.8 ± 2.1 (*n*=17)
Week 2	+1.5 ± 2.1	+0.1 ± 2.6 (*n*=8)	+2.7 ± 2.1 (*n*=15)
Week 3	+0.7 ± 2.6	+0.5 ± 1.8 (*n*=3)	+0.6 ± 1.5 (*n*=7)
Week 4	+0.3 ± 3.0	--------	- 2.3 ± 1.5 (*n*=4)
Week 5	-0.2 ± 3.3	--------	0.0 ± 1.2 (*n*=4)
Week 6	-2.4 ± 3.6	-2.0 ± 2.2 (*n*=2)	-1.1 ± 2.0 (*n*=4)
Week 7	-2.2 ± 3.9	-3.8 ± 1.7 (*n*=2)	-3.8 ± 1.7 (*n*=2)
Week 8	-3.2 ± 4.0	--------	--------

The means and S.D. are for those number of non-finishers (*n*) who dropped from the study the following week. These mean values are always determined 1 week prior to the drop because that was the last measurement that was obtained on these non-finishers. For example, in Week 3 there were 8 drops. Therefore the last measurement available would be in Week 2 for these 8 individuals as represented by the mean and S.D. of +0.1± 2.6.

* The means ± S.D. are for all individuals left by study week for those who eventually ended up dropping from the study. For example, of the 17 volunteers who dropped from the study, at the Week 3 weighing, 7 were still left in the study who are the volunteers on which the mean and S.D. of +0.6 ± 1.5 was determined.

$ From Table 2.1 it was noted that there were a total of 19 volunteers who dropped because of the food. Two of those volunteers do not appear in this table because they switched to the B Ration group immediately upon being deployed, and are included with the B Ration volunteers in Table 3.1. Therefore, there is not a percent weight change as a function of eating the T Rations for these two individuals; hence we began our sample for weight change with 17 volunteers for non-finishers for this table.

criteria increased as the deployment progressed, culminating in the values cited above for the final week.

Body Composition

There were no significant differences ($p > 0.05$) between groups or over time in percent body fat and no interaction effects. Percent body fat loss approached significant levels ($p = 0.08$) for all volunteers over time, with most of the loss occurring in the latter phase of deployment. Means and standard deviations for percent body fat taken at times T1, T2 and T3 are shown in Table 3.3.

Table 3.3. Percent body fat by ration groups (T Ration vs. B Ration) over time (Baseline [T1], 30 days [T2], and 55 days [T3]).

	T Ration (*n=21*)	B Ration (*n=36*)	Total (*n*=57)
Baseline (T1)	12.6 ± 4.7	13.2 ± 4.4	13.0 ± 4.4
30 Days Deployed (T2)	12.6 ± 3.5	13.1 ± 3.9	12.9 ± 3.7
55 Days Deployed (T3)	12.3 ± 3.8	12.6 ± 3.6	12.5 ± 3.7

Gastrointestinal (GI) Distress

The 12 individual figures in Figure 3.3 summarize the percentage of the various symptoms indicated by ration group. Only one symptom, poor appetite, showed a significant difference ($p < 0.05$) between ration groups. Individual t-tests revealed that a greater percentage of people in the T Ration group indicated significantly poorer appetites in Weeks 2, 3, 5, 6 and 7.

There was a significant difference ($p < 0.01$) in the number of bowel movements per day between ration groups (T Ration: 1.5 ± 0.7 movements/day vs. B Ration: 1.3 ± 0.6 movements/day). There were no differences over weeks, and there were also no week-by group interaction effects.

Figure 3.3. Percent of subjective symptoms by ration group over time.

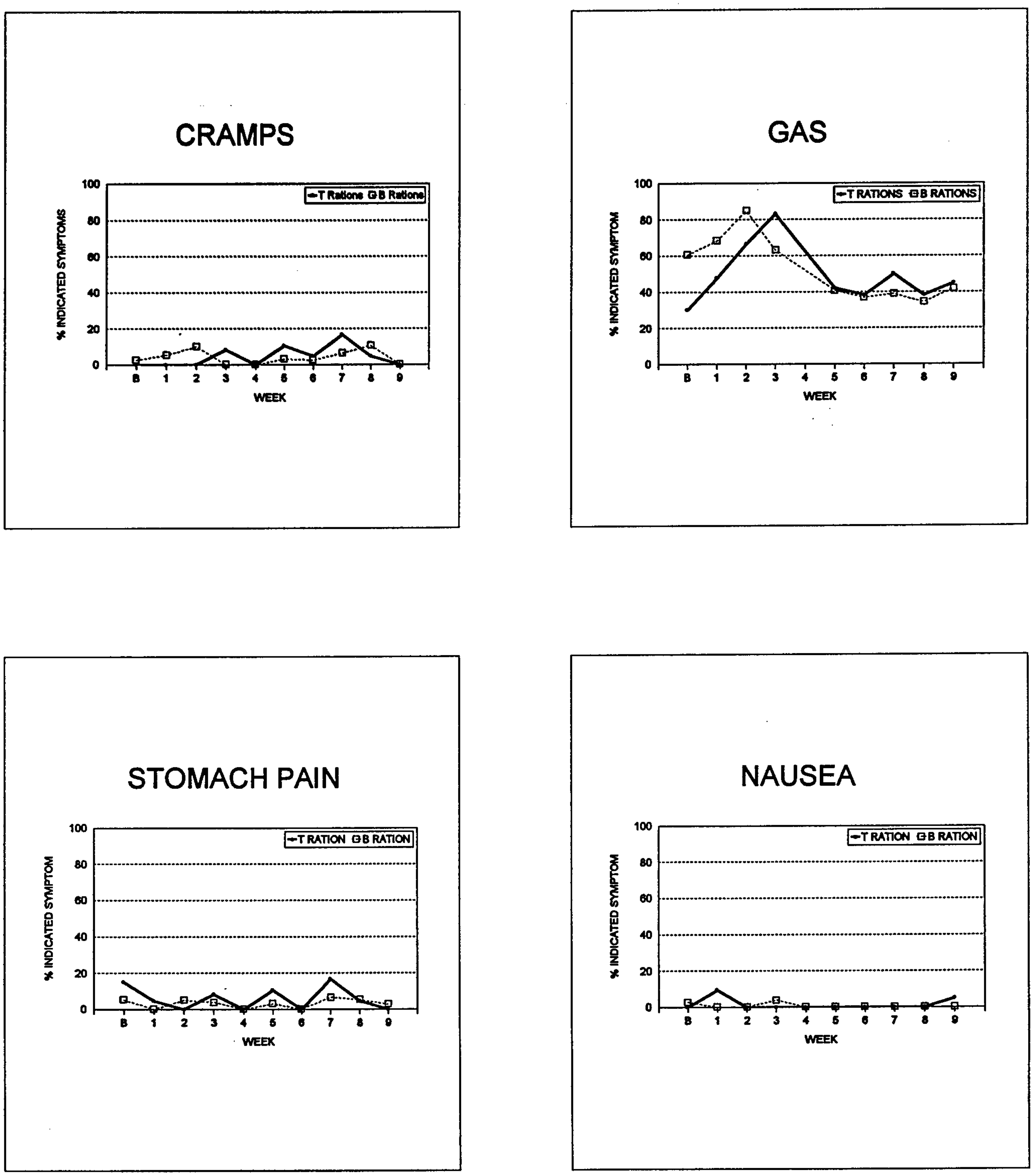


Figure 3.3 (Continued). Percent of subjective symptoms by ration group over time.

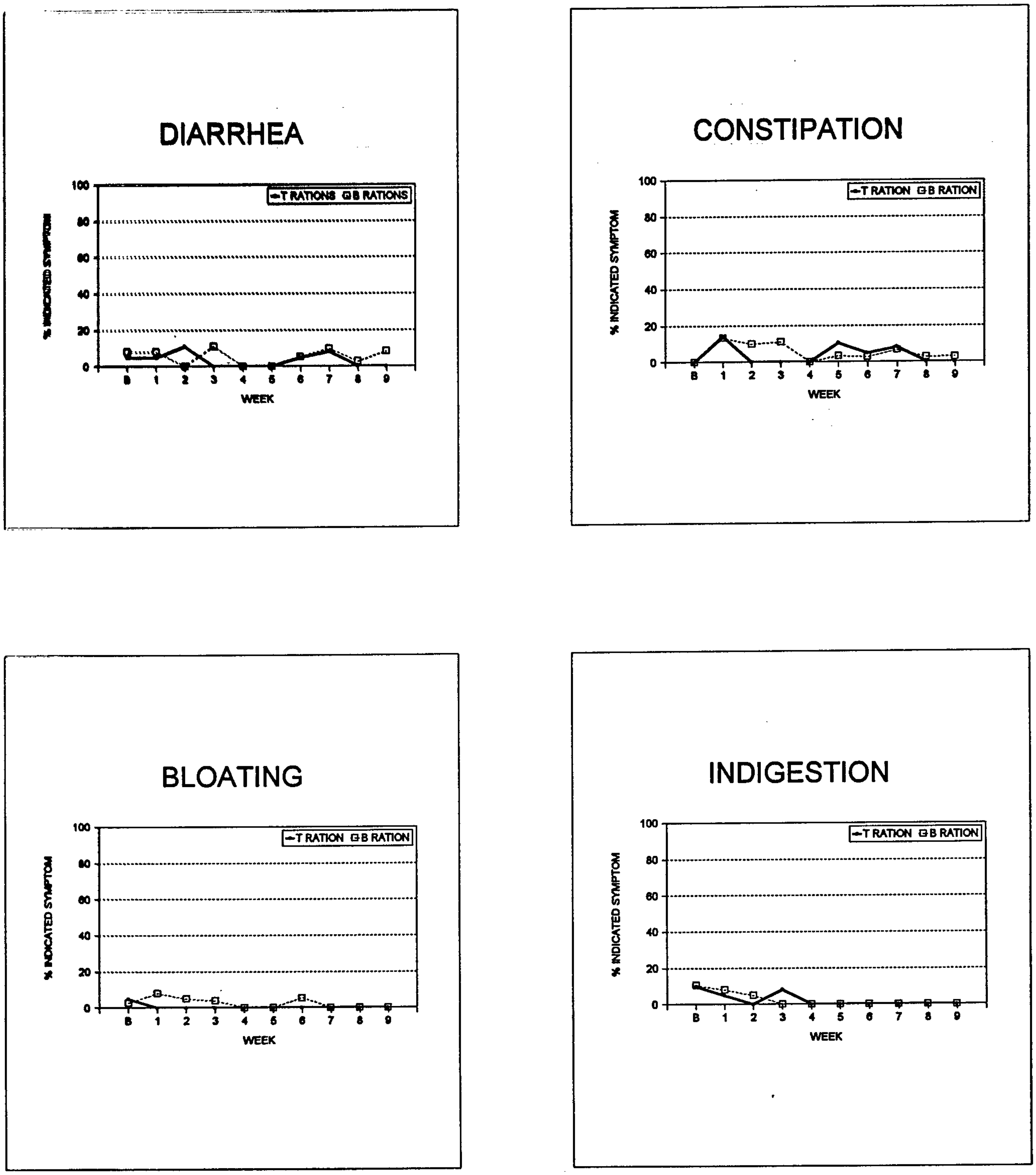
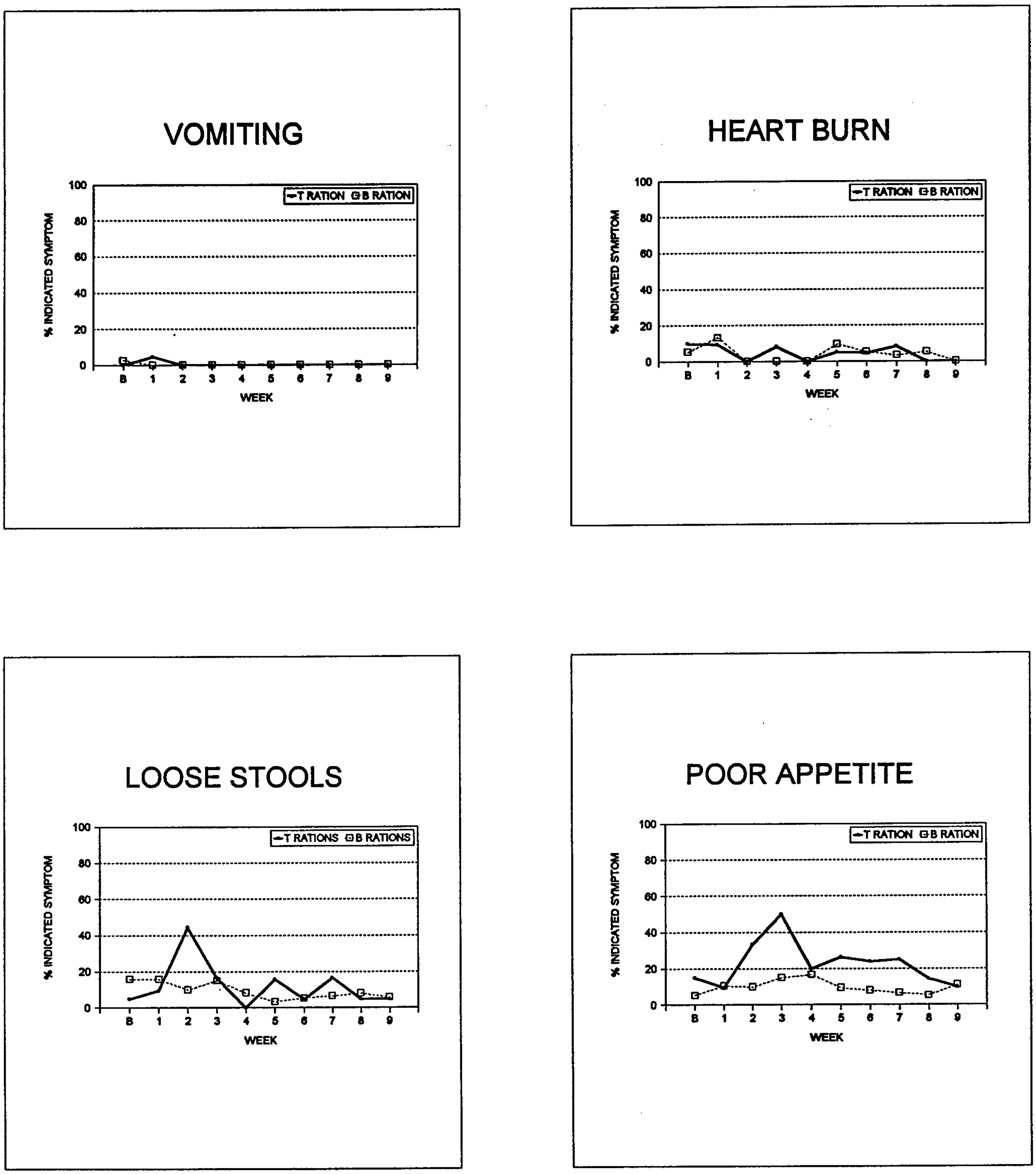


Figure 3.3 (Continued). Percent of subjective symptoms by ration group over time.



DISCUSSION

Weight losses were not excessive for either ration group. Weight losses from baseline exceeded the 3% criterion for both ration groups by Day 56 of the study. Previous research has shown that health and performance can be maintained with weight losses of up to 6% of body weight barring other complications (9). Physical performance results (presented in detail in Chapter 8) during this study were unaffected by weight loss. While percent body fat values of 13.0 ± 4.4% at baseline were lower than college norms (4) and some other military units recently studied (e.g., Special Operation Forces Soldiers: 18.6 ± 5.8% [2], Marine Artillery Unit: 19.7 ± 3.7% [8], and Army Engineer Soldiers 16%-23% [9]), they were not at essential fat levels (approximately 3%-5% body fat), where no weight loss could not be tolerated (4). A 3% weight loss with a corresponding 0.5% body fat reduction over 8 weeks is not excessive. The Army Weight Control Regulation (1) recommends a safe level of weight loss is 1-2 pounds (approximately 1 kg) per week. Those losing weight using the Army guideline could expect to lose about 7 kg by the end of 60 days, which would be about an 8%-9% of baseline body weight. Furthermore, 25% of the individuals reported that they use field exercises as an opportunity to lose weight (Table 2.3).

While the data examining differences between ration groups focus on those volunteers who completed the study, Table 3.2 illustrates that there were no differences in the weight loss patterns of those volunteers who stayed in the study vs. those who dropped out. Therefore, those who did not complete the study were not more severely impacted with respect to weight loss than those who completed the study.

The only symptom between ration groups reported to be associated with GI distress was poor appetite for those consuming the T Rations. The greatest discrepancy occurred during Week 3 (T Rations: 50% vs. B Rations: 18% experienced poor appetites). A high percentage of volunteers from both ration groups indicated they had gas. In general, approximately 50% of the individuals experienced having gas while deployed to the field. For both ration groups these values exceeded 80% at one time; for the B Rations it was during Week 2, while for T Rations it was during Week 3. In general, all the other symptoms associated with GI distress were reported infrequently over the course of the study.

While there was a significant difference in number of bowel movements between ration groups, this difference is not clinically significant. Furthermore, diarrhea was not associated with the consumption of either ration to any significant degree; less than 10% reported it at any one time, and for many weeks the incidence was zero.

CONCLUSIONS

- Weight losses did not differ between those eating the T Rations vs. those eating the B Rations.
- Weight losses exceeded the 3% criterion for rations by Day 56 for those consuming both rations. This rate of weight loss is low and is generally regarded as tolerable and acceptable.
- A small non-significant decrease (0.5%) in percent body fat occurred.
- The only symptom between ration groups reported to be associated with GI distress was poor appetite for those consuming the T Rations. The greatest discrepancy occurred during Week 3 (T Rations: 50% vs. B Rations: 18% experienced poor appetites).
- A high percentage of volunteers from both ration groups indicated they had gas.
- Volunteers consuming T Rations had slightly more bowel movements, but they were less than 2 per day, meaning that there was little practical importance to this statistical finding.

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CHAPTER 4
DIETARY ADEQUACY

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INTRODUCTION

Operational rations are designed for use in field training exercises and actual combat situations. They are designed to be nutritionally adequate for most military personnel for extended, but not limitless, time periods. Nutritional adequacy is contingent on individuals consuming all of the ration. During training and field operations, and presumably in combat, military personnel often do not consume operational rations in amounts necessary to meet energy and nutrient needs (1). The resulting body weight loss and nutrient deficits can compromise health and impair physical and cognitive performance, particularly if over an extended period (10).

Numerous factors, including the environment, the specific eating situation, the ration itself, and the background of the individual, affect the amount of rations that will be consumed. Acceptability of rations is affected by environmental temperature, sensory properties (taste, smell, texture, color, and temperature), packaging, individual food preferences, ease of use, nutritional content, stability of the product, appropriateness to time of day, presentation, availability, variety, and duration of reliance on operational rations as a major source of total food provision. If dissatisfaction with the ration is a major cause of underconsumption, deterioration of morale may compound any health and performance decrements due to poor diet.

Because there are many factors affecting acceptability and consumption, it is important to evaluate the dietary adequacy of feeding systems in operational environments. Field feeding studies of the Meal, Ready-to-Eat (MRE) have observed progressive body weight losses, with average weight losses exceeding 3% attained by three to four weeks of solely MRE feeding (15,16,19,21). These findings have, in part, contributed to the field feeding policy limiting solely MRE feeding to 21 days. There is currently no time limitation policy for the field feeding of Tray Pack Rations (T Rations).

Previous field feeding studies have demonstrated that the provision of at least two hot meals/day during field training exercises promotes energy intakes that more nearly match estimated energy needs than when only MREs are provided (15,16,19,21). However, there has been little research to determine the effect of the type of hot meal (A, B, or T Ration[1]) on energy and nutrient intake. Complete descriptions of T and B Rations have been published previously (20).

In the 1985 Combat Field Feeding System (CFFS) study, the mean energy intake of the group receiving two A Ration meals/day plus one MRE/day was significantly greater than those of the groups receiving two B or two T Rations/day plus one MRE/day. Mean energy intakes of the soldiers in the two B and two T Ration groups were almost identical; however, 37% of the men in the B Ration group, but only 9% of the men in the T Ration group, lost more than 5% of initial body weight (21). Although this would suggest that the T Ration was better than the B Ration in providing for energy needs, it is possible that personnel in the B Ration group had higher energy expenditures.

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[1] **A Rations** include fresh, perishable and semi-perishable foods (meats, fruits, vegetables, and breads), as well as staple foods and require refrigeration and trained cooks.

B Rations are canned and dried foods that do not require refrigeration but do require trained cooks to prepare.

T (Tray Pack) Rations are fully cooked, canned foods requiring only reheating. Used when group feeding is possible.

Subsequent to the CFFS study, the T Rations were modified and enhanced. The CFFS study determined the need to supplement the T Ration with bread and milk. However, until the present study, improved versions of the T Ration have not been directly compared to B Rations, nor had they been evaluated for adequacy when fed for prolonged periods of time. The longest study of a recent version of the T Ration had been 7 days (9). The current field test determined the dietary adequacy of T and B Ration feeding systems during an extended field operation (60 days).

METHODS

Volunteers

There were 43 and 42 volunteers initially randomized to the T Ration and B Ration groups, respectively. Five of these volunteers were women (initially 3 in the T Ration group and 2 in the B Ration group). Their data are presented separately, since dietary requirements and intakes of men and women can differ substantially. The small number of women did not allow for any statistical comparisons.

Two volunteers (1 woman and 1 man) in the T Ration group expressed their desire to drop from the study during the first day of dietary data collection because of strong opposition to consumption of T Rations. One volunteer did not eat pork for religious reasons and was concerned that there were too few pork-free options in the T Ration menu (especially at breakfast) to sustain him. Both volunteers are categorized in the B Ration group and remained in the study. Data for these two volunteers are categorized in the B Ration group for all three test periods.

An additional 23 men later switched ration group allegiance or dropped from the study for various reasons, most commonly because of dissatisfaction with the T Ration (see Chapter 2 for details). Data for volunteers who failed to provide useable dietary data (defined, *a priori*, as complete food intake data, accounting for skipped meals, for at least 5 days during a test period) were excluded from dietary analyses for the incomplete test period.

Data for volunteers who provided useable data for at least one test period are included in the descriptive analyses. Data are categorized according to the ration group participation of the volunteer during each respective test period. Data for volunteers who switched during a data collection period were excluded from the descriptive analyses for that period.

Fifty-one male volunteers (17 in the T Ration group and 34 in the B Ration group) remained in their originally assigned ration group and provided complete data for at least 5 days during all three test periods and, therefore, are included in the data used for the repeated measures analyses of variance (ANOVAs). Most of the results presented are from these volunteers.

Menus

The breakfast and dinner menus served during the three test periods are presented in the Appendix. All menu decisions were left up to the Marine 8th Engineer Support Battalion, with the unit being encouraged to follow their usual field feeding practices.

This study is not an assessment of the T Ration 97 menu, as such, because the Defense Supply Center Philadelphia (DSCP) either did not deliver some items or substituted menus or menu items. In addition, because of the way the rations were palletized and loaded for shipment to the island, some menus were inaccessible in the storage van until other menus were retrieved and, therefore, served frequently. Also, recommended menu enhancements of fresh fruit and salads were provided in very limited amounts. However, this study does evaluate a realistic field feeding situation, in that procurement, delivery, and staffing problems are common occurrences during deployments.

Non-ration foods were available, although not readily accessible, and most constituted an expense for the individual. The Royal Bahamian Defence Force (RBDF) operated a small store on the compound which was open for three 30-60 minute periods most days. The store offered cold soft drinks, chips, crackers, and candy. There was a general store, a bakery, and two restaurants in the town 2 miles away.

Both restaurants served similar offerings of burgers and deep-fried foods—with deep-fried conch being a local speciality. Access to town was limited to mostly liberty periods for the administrative staff and the construction crew working on the RBDF compound. The second construction crew worked in town, and, therefore, had more liberal access to outside foods. A U.S. Coast Guard facility was adjacent to the RBDF compound and became an occasional source of A Ration meals for a few, select Marines. Similarly, the RBDF had a small kitchen on the compound which provided some dinner meals to a few Marines.

Alcohol intake was prohibited during the first two test periods. Immediately following the second test period, the Marines were allowed to consume beer in the compound on Saturday nights.

Food Intake Data Collection

Food and fluid intakes were collected for 6 consecutive days (Saturday through Thursday) during each of the three test periods (T1, T2, and T3). Food records were used to capture consumption of calorie-containing beverages (commercial and ration) consumed outside of scheduled meal times. Total water intake was not obtained because of known errors in self-reported water consumption. Volunteers met twice daily (breakfast and dinner) with the same data collector throughout each data collection phase.

Galley-Provided Foods. A visual estimation method (15) was used to collect intake data for foods and fluids consumed during breakfast and dinner served from the kitchen tent. This method is comparable in accuracy to the weighing method used for estimating individual dietary intakes (18). The visual estimation method used is the most appropriate method to obtain food intake data for volunteers consuming a majority of their foods at a central feeding site.

Recipe specialists obtained a visual standard of each food served at each meal. The visual standards were weighed to the nearest gram using an electronic scale (Sartorious, Brinkman Instruments, Westbury, N.Y.). Volunteers presented their trays to trained data collectors before sitting down to eat. The data collectors recorded the food items and visually compared the portion sizes of foods on the volunteers' trays to the measured standards of the same foods. After the meal, the volunteers returned to the same data collectors, who recorded the quantity of food remaining on the trays. Prior to the study, the dietary data collectors were trained to estimate portion sizes to within 10% of the weight or volume of the visual standard. Each food item was assigned a unique code, which was entered into a computerized coding file along with a serving unit and gram weight. This file was later linked to the food intake data and the nutrient composition data to obtain nutrient intakes for each volunteer per day.

MRE and Pogey Bait Foods (Non-Ration Food and Beverages). Food and beverages consumed outside of the galley were self-reported on 24-hour food records which were reviewed daily by the dietary data collectors. The volunteers were instructed at the beginning of the study on how to fill out the food records. The volunteers were asked to record all foods and beverages immediately after each eating occasion. They reported MRE items in fractions of a package. They reported the estimated portion sizes of pogey bait items as a household measure, dimension, number and size of pieces, or package weight. Water and bulk beverages obtained from the galley were recorded in numbers of cups, canteen cups, or canteens. Marines were also asked to record dietary supplements. The volunteers turned in their food records, as well as a ziplock plastic bag with used wrappers and leftovers, daily. The data collectors inventoried the wrappers to confirm the foods and amounts reported on the food record. Any discrepancies noted were resolved with the respective volunteers at the next meeting.

Nutrient Database

The food composition data used for intake analyses was from Moore's Extended Nutrient (MENu) database of the Pennington Biomedical Research Center (PBRC), augmented with military ration data provided by USARIEM's Military Nutrition & Biochemistry Division. Data from MENu were derived from Release 11 of the U.S. Department of Agriculture (USDA) Nutrient Data Base for Standard Reference (22) and the USDA Survey Nutrient Data Base for the Continuing Survey of Food Intakes by

Individuals, Release 7 (21). PBRC incorporates the latest data from the USDA when they become available, and these two datasets were the most recent at the time of analyses. The Military Dietary Assessment System (MiDAS) software, developed by PBRC, was used for data entry. MiDAS was designed to capture various types of nutritional data collected during research studies. MiDAS accommodates data collected from food records as well as from visual estimation.

The nutrient content of the ration items was available from laboratory determinations made by the Soldier Systems Command (SSC), Natick; from manufacturers' data; or USDA data for similar items. The MRE issued to the Marines during this study was MRE XVI. The MRE data used for nutrient intake analyses comprised the latest available information for average MRE XVI components. No corrections were made for the specific manufacturer and lot or for nutrient losses that occur during storage. The nutrient content of T Ration items was based on data provided by the Sustainability Directorate, SSC. Data for T Ration items with discrepant or missing nutrient data were obtained by computer calculations of the product specifications. The energy and macronutrient data used in this report for the military rations may be obtained from USARIEM's Military and Nutrition Division (Baker-Fulco, unpublished data).

The nutrient contents of select T Ration items and foods prepared in the field kitchen were calculated with a recipe analysis system developed by PBRC using the MENu database. Recipe specialists recorded the recipes for B Ration items as prepared. Information collected on recipes included the specific ingredients, the weight or volume of ingredients, and preparation methods so that accurate computerized nutrient analyses of the recipes could be made.

Nutrient Intake

The dietary intake data captured by visual estimation and food record were combined with the food composition data to calculate nutrient intakes from each food and beverage consumed each day. The Statistical Package for the Social Sciences (SPSS) for Windows—1995 (SPSS, Inc., Chicago, IL) was used to aggregate the dietary intake data to derive total nutrient intakes for each volunteer for each study day and then calculate mean daily intakes by study period. Nutrients reported were energy, carbohydrate, protein, total fat, total dietary fiber, cholesterol, total monounsaturated fat, total polyunsaturated fat, total saturated fat, vitamin A, carotene, vitamin E, thiamin, niacin, riboflavin, folate, vitamin B_6, vitamin B_{12}, vitamin C, calcium, phosphorus, magnesium, iron, zinc, sodium, and potassium. For each data collection period, mean dietary intakes for each nutrient were analyzed, as well as the caloric distribution from protein, fat, and carbohydrate. The nutritional adequacy of the actual dietary intakes of the Marines was determined by comparing the calculated nutrient intakes and caloric distributions to the MRDA (5) and to accepted nutrition standards (23).

Data Analysis

Data from volunteers with at least 5 days of complete data per test period for all test periods were used to determine differences in dietary intake between ration groups and over time. Initially, a repeated measures multivariate analysis of variance (MANOVA) was used to determine if there were significant differences in nutrient intakes between ration groups and between test periods and whether there were significant interactions between the test group and the test period. Because the MANOVA was significant ($p < 0.001$) for both ration group main effects and ration group by test period interaction effects ($p < 0.005$), subsequent univariate repeated measures ANOVAs were performed to determine which nutrient intakes were significantly different. Because intakes of many nutrients are more related to the total amount of food consumed than to specific foods in the diet, repeated measures analyses of covariance (ANCOVAs) were also performed with energy used as the covariate. However, actual means and standard deviations are presented rather than the adjusted means. Post hoc analyses to determine the location of significant differences were performed using Tukey's significant difference tests. Statistical significance was established at $p \leq 0.05$ for all tests.

Data for volunteers who provided complete dietary data for at least one test period were included in the descriptive analyses. Data for volunteers who switched from the T Ration group to the B Ration group are categorized according to the ration actually consumed during each respective test period. Data for volunteers who switched <u>during</u> a test period were excluded from descriptive analyses for that period.

Data for volunteers who switched after the first day of dietary data collection were excluded from any comparative statistical analyses. Likewise, descriptive data from the five female volunteers were presented, but their data were not included in any comparative analyses.

Limitations of the Study

Volunteers who withdrew from the study did not have to continue in the same ration group to which they had been assigned and, thus, there was little incentive to keep dissatisfied volunteers from dropping. A description of volunteers who dropped from the study is in Chapter 2. Volunteers in the two ration groups were not physically separated. Therefore, those assigned to the T Ration group (i.e., the only group with volunteers who dropped for food-related reasons) could directly compare their ration provision to that of the B Ration group. If this comparison led to feelings of relative deprivation or sacrifice, food consumption, as well as acceptability ratings could have been affected, even for volunteers who completed the study.

Because the procurement, delivery, and service of menu items were not as specified in the T Ration 97 menu, this study may not be an accurate evaluation of the T Ration menu. However, since it is common for the DSCP to allow substitution of menus or menu items or to be unable to provide all menus requested, this study is clearly a reliable evaluation of a realistic field feeding situation.

There is inadequate food composition data for some essential nutrients and beneficial food components. Nutrients reported are those with little missing data in the food composition databases used. However, intakes of some nutrients, such as vitamin A and carotene, may still be underestimated because any modest gaps in the nutrient database were replaced by very conservative imputations.

There were many discrepancies in the nutrient data provided for T Ration items, the sources of which could not be confirmed; i.e., single sample or average multiple sample laboratory assay, manufacturers' data, or calculated imputation. Nutrients with discrepant values were imputed from calculations based on product specifications or values for similar items in the USDA Standard Reference Release 11 Nutrient

Database.

Nutrient composition of foods varies with the season of production, the processing methods and formulas of different producers, storage and handling, and preparation methods. The food composition data used for intake analyses are mostly average values of manufacturers' samples and do not necessarily reflect nutrient content of items at the time of consumption. Because of the expense of laboratory assays for nutrient content, the nutrient data averages may be based on occasional food samples from a few of the suppliers and may not match actual products consumed during this study. In addition, the ration composition data do not reflect nutrient losses that occur during prolonged or high-temperature storage. Although storage temperatures of the rations used during this study are not available, it is estimated that they exceeded 120° F inside the unshaded storage containers.

RESULTS

Absolute Nutrient Intakes

Fifty-one men remained in their originally assigned ration group and provided useable data for all three test periods. Their average body weight and body mass indices (BMI)[2] at the start of the study were 79.2 ± 10.3 kg and 24.9 ± 2.5, respectively. There were no differences between groups.

Tables 4.1 to 4.3 summarize the energy and nutrient intake data of volunteers included in the repeated measures ANOVAs. Table 4.1 presents mean daily intakes, averaged over the entire study, for all reported nutrients for the T and B Ration groups and statistical significance of the group differences, with and without adjusting for energy intake. The average daily intake of the B Ration group (2866 ± 549 kcal/day) was significantly greater than the energy intake of the T Ration group (2572 ± 241 kcal/day) ($p \leq 0.05$). Volunteers in the B Ration group consumed, overall, significantly more ($p \leq 0.05$):

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[2] **Body Mass Index** is calculated as Wt in kg/Ht in m^2

- Carbohydrate*
- Fiber*
- Cholesterol*
- Vitamin A*
- Folate*
- Thiamin
- Vitamin C*
- Magnesium
- Phosphorus*
- Sodium

*Differences Linked to Total Energy Consumed

After controlling for total energy intake, only intakes of thiamin, magnesium, and sodium remained significantly higher in the B Ration group than in the T Ration group. When adjusted for energy intake, saturated fatty acid and polyunsaturated fatty acid intakes were slightly but significantly ($p < 0.05$) higher in the T Ration group than in the B Ration group, while monounsaturated fatty acid intake was slightly higher in the B Ration group than in the T Ration group ($p < 0.05$) .

Table 4.2 shows the combined mean daily energy and nutrient intakes for each of the three test periods. Dietary intakes of most nutrients were highest during the first test period and significantly declined during subsequent test periods. The decreases in intakes of protein and fat were related to the decreases in overall energy intakes as were the declines in cholesterol, folate, and magnesium.

Significant ration group by test period interaction effects were observed for the following nutrients:

- Carbohydrate#
- Protein#
- Fat#
- Fiber
- Cholesterol
- Saturated Fatty Acids
- Carotene*
- Thiamin#
- Niacin#
- Vitamin E
- Calcium*
- Phosphorus
- Niacin#
- Vitamin E
- Potassium
- Zinc#

* Differences Linked to Total Energy Consumed

\# Differences Observed After Controlling for Total Energy Consumed

Table 4.1. Energy and nutrient intakes (mean ± S.D.) for the entire study by T and B Ration groups.

Nutrient	MRDA[1]	Ration Group T Ration (n=17)	B Ration (n=34)	ANOVA p ≤	ANCOVA p ≤
Energy (Kcal)	2800-3600	2572 ± 341	2866 ± 549	0.05	
Carbohydrate (g)	–[2]	313 ± 60	361 ± 69	0.02	NS
Protein, (g)	100	99 ± 14	104 ± 22	NS	NS
Fat (g)	–[3]	102 ± 16	114 ± 27	NS	NS
Alcohol (g)		1.7 ± 2.8	2.8 ± 3.6	NS	NS
Fiber (g)	–[4]	15.7 ± 3.8	18.5 ± 4.2	0.03	NS
Cholesterol, mg	–[5]	392 ± 105	488 ± 121	0.008	NS
Saturated Fatty Acids (g)		33.5 ± 8.4	31.3 ± 9.9	NS	0.0003
Monounsaturated F.A. (g)		33.6 ± 8.9	35.9 ± 5.6	NS	0.0001
Polyunsaturated F.A. (g)		15.7 ± 3.0	12.6 ± 3.8	0.005	0.0001
Vitamin A (μg RE)	1000	1123 ± 384	1442 ± 573	0.04	NS
Carotene (RE)		348 ± 72	425 ± 187	NS	NS
Folate (μg)	400	214 ± 86	287 ± 103	0.02	NS
Thiamin (mg)	1.6	2.1 ± 0.5	2.9 ± 0.9	0.0009	0.007
Niacin (mg)	21	25.2 ± 5.0	28.1 ± 7.9	NS	NS
Riboflavin (mg)	1.9	2.6 ± 0.7	2.7 ± 0.7	NS	NS
Vitamin B_6 (mg)	2.2	2.4 ± 0.4	2.7 ± 0.9	NS	NS
Vitamin B_{12} (μg)	3.0	6.5 ± 1.9	6.2 ± 2.0	NS	NS
Vitamin C (mg)	60	125 ± 43	174 ± 69	0.01	NS
Vitamin E (mg αTE)	10	13.0 ± 3.4	12.6 ± 5.3	NS	NS

Table 4.1 (Continued). Energy and nutrient intakes (mean ± S.D.) for the entire study by ration group.

Nutrient	MRDA[1]	Ration Group T Ration (n=17)	B Ration (n=34)	ANOVA $p \le$	ANCOVA $p \le$
Calcium (mg)	800-1200	1098 ± 457	1172 ± 442	NS	NS
Iron (mg)	10	16.2 ± 3.9	18.5 ± 5.8	NS	NS
Magnesium (mg)	350-400	305 ± 56	362 ± 75	0.007	0.05
Phosphorus (mg)	800-1200	1643 ± 371	1949 ± 471	0.02	NS
Potassium (mg)	–[6]	3124 ± 613	3528 ± 755	NS	NS
Sodium (mg)	–[7]	4307 ± 512	5115 ± 1064	0.005	0.04
Zinc (mg)	15	15.0 ± 3.0	13.5 ± 4.4	NS	NS

[1]Military Recommended Dietary Allowances (MRDA) for men, ages 17-50 (U.S. Department of the Army, AR 40-25, 1985).

[2]Carbohydrate intake should be between 50%-55% of total energy intake.

[3]Fat intake should be less than 35% of total energy intake.

Recommendations for dietary fiber intake for adults generally fall in the range of 20-35 g/day or 10-13 g dietary fiber per 1,000 kcal.

[5]Suggested maximum intake for cholesterol is 300 mg/day.

[6]Estimated safe and adequate intake is 1875-5625 mg of potassium.

[7]Target for sodium is 1400-1700 mg per 1000 kcal (i.e., 3920-6120 mg). National guidelines suggest < 2400 mg/day.

Table 4.2. Energy and nutrient intakes (mean ± S.D.) for each test period.

Nutrient	MRDA[1]	TEST PERIOD T1 n=51	T2 n=51	T3 n=51	ANOVA $p \leq$	ANCOVA $p \leq$
Energy (Kcal)	2800-3600	2963 ± 559	2739 ± 632	2602 ± 598	0.003	
Carbohydrate (g)	--[2]	377 ± 76	336 ± 87	323 ± 81	0.0001	0.005
Protein (g)	100	108 ± 24	104 ± 25	95 ± 24	0.008	NS
Fat (g)	--[3]	119 ± 28	111 ± 31	100 ± 29	0.0003	NS
Alcohol (g)		0.0 ± 0.0	0.0 ± 0.0	7.2 ± 10.1	0.0001	0.001
Fiber (g)	--[4]	21.7 ± 5.8	16.1 ± 4.8	14.8 ± 4.2	0.0001	0.001
Cholesterol (mg)	--[5]	488 ± 141	485 ± 174	395 ± 155	0.009	NS
Saturated Fatty Acids (g)		33.2 ± 10.8	33.6 ± 11.4	29.3 ± 10.8	NS	0.0002
Monounsaturated F.A. (g)		36.8 ± 8.8	34.3 ± 10.7	32.0 ± 9.6	0.02	NS
Polyunsaturated F.A. (g)		15.4 ± 4.5	12.7 ± 4.6	12.8 ± 5.3	0.009	NS
Vitamin A (μg RE)	1000	1563 ± 688	1237 ± 608	1208 ± 590	0.0002	0.02
Carotene (RE)		541 ± 295	378 ± 222	281 ± 162	0.0001	0.0001
Folate (μg)		289 ± 113	268 ± 140	232 ± 118	0.01	NS
Thiamin (mg)	1.6	2.8 ± 0.9	2.4 ± 0.7	2.7 ± 1.1	NS	0.02
Niacin (mg)	21	28.1 ± 7.3	26.3 ± 10.0	26.9 ± 9.3	NS	NS
Riboflavin (mg)	1.9	2.8 ± 0.9	2.8 ± 1.0	2.4 ± 0.8	0.003	0.003
Vitamin B_6 (mg)	2.2	3.0 ± 0.9	2.3 ± 0.9	2.6 ± 0.9	0.0001	0.0001
Vitamin B_{12} (μg)	3.0	6.8 ± 2.4	7.1 ± 2.8	5.0 ± 2.2	0.0001	0.0001
Vitamin C (mg)	60	209 ± 90.3	128 ± 66	136 ± 80.2	0.0001	NS
Vitamin E (mg αTE)	10	13.9 ± 4.3	12.5 ± 7.2	11.7 ± 6.0	NS	NS

Table 4.2 (Continued). Energy and nutrient intakes (mean ± S.D.) for each test period.

Nutrient	MRDA[1]	TEST PERIOD T1	T2	T3	ANOVA $p \leq$	ANCOVA $p \leq$
Calcium (mg)	800-1200	1168 ± 522	1275 ± 553	999 ± 471	0.0004	0.0001
Iron (mg)	10	19.5 ± 5.6	18.2 ± 7.3	15.6 ± 6.5	0.0003	0.0001
Magnesium (mg)	350-400	372 ± 92	342 ± 89	315 ± 82	0.0002	NS
Phosphorus (mg)	800-1200	1922 ± 574	1962 ± 561	1656 ± 487	0.0007	0.0001
Potassium (mg)	–[6]	3877 ± 940	3367 ± 878	2936 ± 735	0.0001	0.0001
Sodium (mg)	–[7]	5462 ± 1244	4752 ± 1164	4323 ± 1163	0.0001	0.0002
Zinc (mg)	15	14.5 ± 4.0	14.9 ± 5.8	12.6 ± 4.9	0.004	0.02

[1]Military Recommended Dietary Allowances (MRDA) for men, ages 17-50 (U.S. Department of the Army, AR 40-25, 1985).

[2]Carbohydrate intake should be between 50%-55% of total energy intake.

[3]Fat intake should be less than 35% of total energy intake.

Recommendations for dietary fiber intake for adults generally fall in the range of 20-35 g/day or 10-13 g dietary fiber per 1,000 kcal.

[5]Suggested maximum intake for cholesterol is 300 mg/day.

[6]Estimated safe and adequate intake is 1875-5625 mg of potassium.

[7]Target for sodium is 1400-1700 mg per 1000 kcal (i.e., 3920-6120 mg). National guidelines suggest < 2400 mg/day.

Table 4.3. Energy and nutrient intakes (mean ± S.D.) by ration group and test period.

Nutrient	MRDA[1]	TEST PERIOD							
		T1		T2		T3		ANOVA	ANCOVA
		T (n=17)	B (n=34)	T (n=17)	B (n=34)	T (n=17)	B (n=34)	$p \leq$	$p \leq$
Energy (Kcal)	2800-3600	2702 ± 480	3094 ± 556	2589 ± 554	2813 ± 662	2423 ± 445	2692 ± 648	NS	
Carbohydrate (g)	–[2]	343 ± 72	394 ± 73	314 ± 89	348 ± 84	282 ± 62	343 ± 82	NS	0.04
Protein (g)	100	105 ± 20	109 ± 26	96 ± 22	108 ± 25	96 ± 19	95 ± 26	NS	0.0007
Fat (g)	–[3]	105 ± 22	126 ± 28	105 ± 24	114 ± 34	96 ± 25	102 ± 31	NS	0.05
Alcohol (g)		0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	5.1 ± 8.5	8.3 ± 10.8	NS	NS
Fiber (g)	–[4]	18.4 ± 4.9	23.4 ± 5.5	15.0 ± 5.5	16.6 ± 4.5	13.5 ± 4.0	15.4 ± 4.3	0.02	0.04
Cholesterol (mg)	–[5]	392 ± 117	535 ± 128	378 ± 136	538 ± 168	405 ± 139	389 ± 164	0.0001	0.0001
Saturated Fatty Acids (g)		32.3 ± 9.8	33.7 ± 11.4	34.6 ± 11.0	33.1 ± 12.3	33.6 ± 10.9	27.2 ± 10.2	0.04	0.001
Monounsaturated F.A. (g)		37.4 ± 7.6	36.5 ± 9.4	35.4 ± 8.8	33.7 ± 11.6	34.8 ± 8.9	30.7 ± 9.8	NS	NS
Polyunsaturated F.A. (g)		17.1 ± 4.3	14.5 ± 4.5	14.9 ± 3.9	11.5 ± 4.5	15.0 ± 5.5	11.6 ± 5.0	NS	NS
Vitamin A (μg RE)	1000	1291± 649	1699± 675	988 ± 388	1362 ± 663	1090 ± 372	1267 ± 670	NS	NS
Carotene (RE)		456 ± 213	583 ± 323	206 ± 57	464 ± 224	383 ± 183	229 ± 123	0.0001	NS
Folate (μg)		237 ± 150	315 ± 79	220 ± 99	291 ± 152	187 ± 51	255 ± 136	NS	NS
Thiamin (mg)	1.6	2.3 ± 0.7	3.0 ± 0.9	2.0 ± 0.6	2.6 ± 1.1	1.9 ± 0.6	3.1 ± 1.2	NS	0.008
Niacin, mg	21	28.4 ± 8.4	28.0 ± 6.8	22.9 ± 8.0	28.0 ± 10.5	24.3 ± 5.1	28.3 ± 10.6	NS	0.004
Riboflavin (mg)	1.9	2.6 ± 1.0	2.9 ± 0.8	2.7 ± 0.9	2.9 ± 1.0	2.4 ± 0.8	2.3 ± 0.9	NS	NS
Vitamin B_6 (mg)	2.2	3.0 ± 0.6	3.1± 1.1	2.0 ± 0.6	2.4 ± 1.0	2.4 ± 0.7	2.7 ± 1.1	NS	NS

Table 4.3 (Continued). Energy and nutrient intakes (mean ± S.D.) by ration group and test period.

Nutrient	MRDA[1]	TEST PERIOD							
		T1		T2		T3		ANOVA	ANCOVA
		T (n=17)	B (n=34)	T (n=17)	B (n=34)	T (n=17)	B (n=34)	$p \leq$	$p \leq$
Vitamin B_{12} (μg)	3.0	6.7 ± 2.4	6.8 ± 2.4	7.5 ± 2.9	6.9 ± 2.8	5.2 ± 1.7	4.9 ± 2.4	NS	NS
Vitamin C (mg)	60	177± 74	225 ± 94	97 ± 51	143 ± 67	102 ± 52	154 ± 87	NS	NS
Vitamin E (mgαTE)	10	15.2 ± 5.6	13.3 ± 3.6	12.2 ± 5.6	12.7 ± 7.9	11.7 ± 3.6	11.7 ± 7.0	NS	NS
Calcium (mg)	800-1200	914 ± 437	1295 ± 519	1286 ± 553	1269 ± 561	1095 ± 547	951 ± 429	0.0002	NS
Iron (mg)	10	17.7 ± 6.6	20.4 ± 4.9	17.1 ± 5.6	18.8 ± 8.1	13.8 ± 2.7	16.5 ± 7.6	NS	NS
Magnesium (mg)	350-400	324 ± 78	396 ± 90	308 ± 79	359 ± 89	282 ± 68	332 ± 84	NS	NS
Phosphorus (mg)	800-1200	1565 ± 421	2101± 561	1765 ± 496	2061 ± 573	1598 ± 467	1685 ± 501	0.008	0.0001
Potassium (mg)	–[6]	3360 ± 739	4135 ± 931	3111 ± 832	3495 ± 884	2900 ± 656	2953 ± 780	0.006	0.0002
Sodium (mg)	–[7]	4752 ± 776	5817 ± 1290	4170 ± 807	5043 ± 1218	4000 ± 847	4485 ± 1272	NS	NS
Zinc (mg)	15	16.6 ± 5.3	13.5 ± 3.2	15.1 ± 4.7	14.8 ± 6.4	12.1 ± 5.6	12.1 ± 5.6	NS	0.0001

[1]Military Recommended Dietary Allowances (MRDA) for men, ages 17-50 (U.S. Department of the Army, AR 40-25, 1985).

[2]Carbohydrate intake should be between 50%-55% of total energy intake.

[3]Fat intake should be less than 35% of total energy intake.

Recommendations for dietary fiber intake for adults generally fall in the range of 20-35 g/day or 10-13 g dietary fiber per 1,000 kcal.

[5]Suggested maximum intake for cholesterol maximum is 300 mg/day.

[6]Estimated safe and adequate intake is 1875-5625 mg of potassium.

[7]Target for sodium is 1400-1700 mg per 1000 kcal (i.e., 3920-6120 mg). National guidelines suggest < 2400 mg/day.

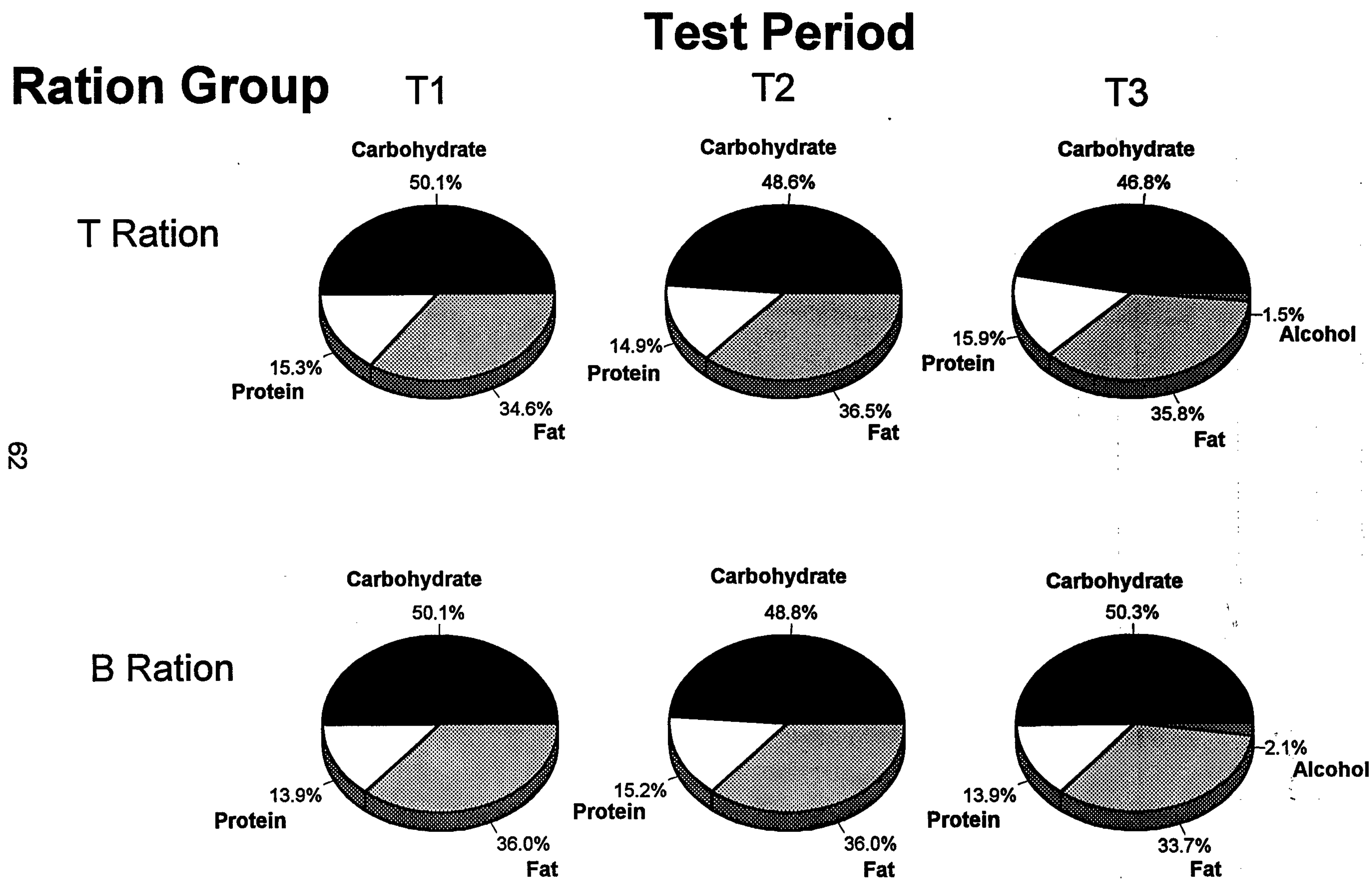
Table 4.3 presents mean nutrient intakes for each ration group for the three test periods and the significance of the effects of any ration group by test period interaction. Statistical significance indicates that the difference in nutrient intakes for the entire study sample (those assigned to both the T and B Ration groups) changed over time. Energy intakes declined over time ($p \leq 0.003$), as may be seen in Table 4.2. When energy intakes are expressed on the basis of body weight, the drop in energy intakes was much steeper in the B Ration group than in the T Ration group. Energy intakes in the B Ration group declined from 39.9 ± 7.7 to 35.9 ± 8.3 to 35.9 ± 8.6 kcal/kg body weight, while energy intakes in the T Ration group were more stable, ranging from 32.1 ± 7.6 to 31.5 ± 7.3 to 31.9 ± 7.6 kcal/kg body weight over the three test periods.

Macronutrient Distributions

Figure 4.1 shows the proportion of energy derived from carbohydrate, protein, fat, and alcohol for the two groups in the three test periods. Data presented are for the volunteers providing complete dietary data for all test periods. Despite differences in total energy intake, the proportions of energy from carbohydrate and fat were fairly similar for both groups during the first two test periods. Volunteers in both ration groups derived a mean of 50.1% of their calories from carbohydrate during the first period. The proportion of carbohydrate in the diets of both groups declined to almost identical percentages (48.6% of calories in the T Ration group and 48.8% of calories in the B Ration group) by the second test period. Fat provided 34.6% and 36.0% of the calories, respectively, in the diets of the T Ration and B Ration groups during the first test period. The T Ration group obtained a greater percentage of their calories from fat during the second test period (36.5%), while the B Ration group maintained their fat intake at 36.0% of calories.

The proportion of calories from protein during the first test period averaged 15.3% for the T Ration group and 13.9% for the B Ration group. During the second test period, the percentages of calories from protein were more similar (14.9% for the T Ration group and 15.2% for the B Ration group), but they diverged again, so that by the third test period, the T Ration group derived significantly more calories from protein (15.9%) than did the B Ration group (13.9%). The proportion of carbohydrate in the diet

Figure 4.1. Proportion of energy derived from the macronutrients and alcohol for both ration groups for each test period.



of volunteers in the T Ration group continued to decline from the second to the third test period, while that of the B Ration group rebounded. By the third test period, the T Ration group derived a lesser proportion of energy from carbohydrate (46.8%) and a greater proportion of energy from fat (35.8%) than did the B Ration group (50.3% of calories from carbohydrate and 33.7% of calories from fat).

Sources of Nutrient Intakes

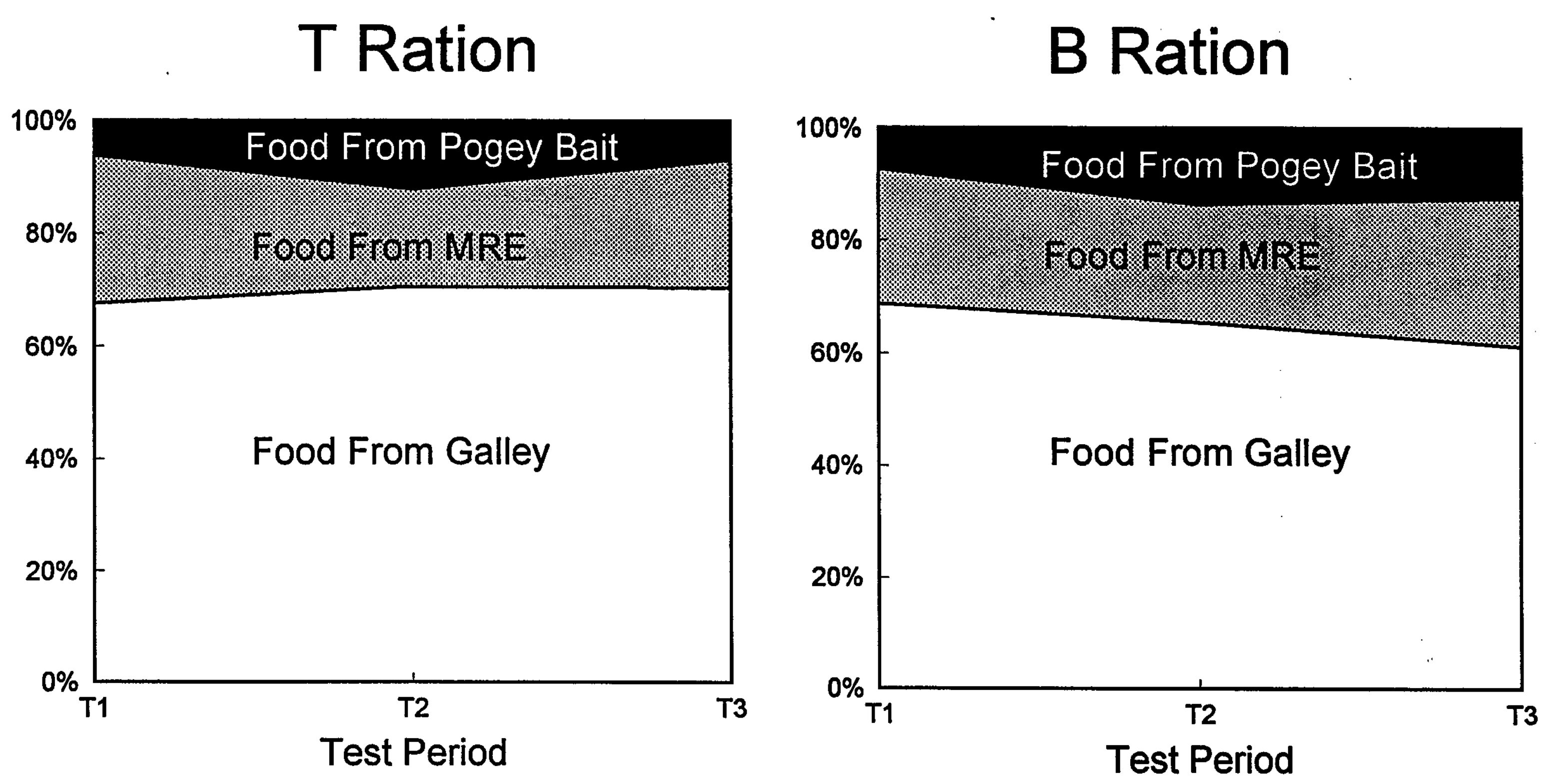
Intakes of energy and select nutrients were further analyzed to reveal their sources; i.e., whether from galley foods, MREs or pogey bait. Nutrients examined were carbohydrate, protein, fat, dietary fiber, cholesterol, saturated fatty acids, vitamin A, carotene, folate, vitamin C, vitamin E, calcium, magnesium, zinc, and sodium. Table 4.4 summarizes absolute and proportional energy intakes from each source by ration group and test period for the volunteers providing complete dietary data. Figure 4.2 shows the proportion of total energy from the three food sources available for each ration group and test period.

Table 4.4. Proportion of total energy intake from each source.

	Test Period	Food Source					
		Galley		MRE		Pogey Bait	
		kcal/day	% of total	kcal/day	% of total	kcal/day	% of total
T Ration Group (n=17)	T1	1820	67.5	709	26.3	164	6.1
	T2	1824	70.7	448	17.3	307	12.2
	T3	1703	70.3	552	22.8	168	6.9
	Study Mean	*1782*	*69.4*	*570*	*22.2*	*216*	*8.4*
B Ration Group (n=34)	T1	2127	67.5	741	23.9	227	7.3
	T2	1847	63.5	591	20.9	384	13.6
	T3	1643	59.6	710	26.4	334	12.4
	Study Mean	*1872*	*65.1*	*681*	*23.7*	*315*	*11.0*

Galley foods provided a significantly greater ($p \leq 0.001$) proportion of total energy intake than did MREs or pogey bait. During the entire study, the T Ration group

Figure 4.2. Proportion of energy (kcal) from various sources by ration type.



obtained 69.4% of their total energy intake from galley foods, 22.2% of energy from MREs, and 8.4% of energy from pogey bait. The B Ration group obtained means of 65.3%, 23.7%, and 11.0% of their total energy intake from galley foods, MREs, and pogey bait, respectively. Despite differences in energy intake, the two ration groups were similar in the proportion of energy derived from the three food sources during the first test period. During each subsequent test period, however, the B Ration group obtained a lesser percentage of energy from galley foods, whereas the T Ration group derived a slightly greater or similar percentage of energy from galley foods during the second and then third test period. As the B Ration group obtained less of their declining energy intake from galley foods, they increasingly relied on both MRE and pogey bait foods. This shift in sources between ration groups over the course of the study was statistically significant ($p \leq 0.03$).

Not unexpectedly, examination of the sources of nutrient intakes revealed that, as for energy, galley food was the major provider of all nutrients analyzed by source for both ration groups. Table 4.5 reports the absolute and proportional intakes for nutrients analyzed by source. For most nutrients, the proportional contributions of the three sources toward total nutrient intakes followed the same general pattern as those for total energy intake, but with slightly higher percentages for galley foods and lesser percentages for pogey bait. Galley foods provided much greater proportions of the total calcium intake (83.0% in the T Ration group and 79.1% in the B Ration group) than they did for total energy intake (69.4% and 65.1%, respectively). Cholesterol was also provided in disproportionately higher amounts by galley foods. Most of the dietary cholesterol consumed (~85% of total intake) came from galley foods. The higher cholesterol intake by those in the B Ration group was mostly due to intake from galley foods ($p \leq 0.001$); the dietary cholesterol contributions by MREs and pogey bait were very similar for the two ration groups. The bulk of daily dietary fiber was also provided by galley food (11.1 g/day or 71.7% in the T Ration group and 12.7 g/day or 67.8% in the B Ration group; $p \leq 0.001$). It should be noted that these values of dietary fiber are much lower than the recommended intake of 25 g/day.

Table 4.5. Absolute intake and proportion of total nutrient intake by source.

Carbohydrate	Test Period	Food Source: Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	230	67.5	86	25.3	25	7.3
	T2	212	67.4	58	18.3	45	14.3
	T3	189	66.8	70	24.9	24	8.4
	Study Mean	*210*	*67.2*	*71*	*22.8*	*31*	*10.0*
B Ration Group (*n*=34)	T1	265	67.5	94	23.8	34	8.7
	T2	221	63.5	74	21.3	53	15.2
	T3	204	59.6	86	25.2	52	15.2
	Study Mean	*230*	*69.7*	*85*	*23.4*	*46*	*13.0*

Protein	Test Period	Food Source: Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	73	70.9	27	25.7	4	6.1
	T2	68	71.3	16	17.2	11	12.2
	T3	74	77.3	20	20.6	2	6.9
	Study Mean	*72*	*73.2*	*21*	*21.2*	*6*	*8.4*
B Ration Group (*n*=34)	T1	77	70.3	26	23.5	7	7.3
	T2	77	70.9	20	18.5	12	13.6
	T3	65	68.0	25	26.2	5	12.4
	Study Mean	*73*	*69.7*	*24*	*22.7*	*8*	*11.1*

Fat	Test Period	Food Source: Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	69	65.7	30	28.7	6	5.6
	T2	77	73.2	18	16.8	11	10.1
	T3	70	72.8	22	23.3	4	3.9
	Study Mean	*72*	*70.6*	*23*	*22.9*	*7*	*6.5*
B Ration Group (*n*=34)	T1	88	69.5	31	24.5	8	6.1
	T2	75	65.4	25	21.9	14	12.7
	T3	65	64.0	31	30.6	6	5.4
	Study Mean	*76*	*66.3*	*29*	*33.8*	*9*	*8.1*

Table 4.5 (Continued). Absolute intake and proportion of total nutrient intake by source.

Dietary Fiber	Test Period	Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	13.1	72.5	4.3	23.6	0.7	3.9
	T2	10.8	71.7	3.2	21.2	1.1	7.1
	T3	9.6	70.8	3.4	25.1	0.5	4.0
	Study Mean	*11.1*	*71.7*	*3.6*	*23.3*	*0.8*	*5.0*
B Ration Group (*n*=34)	T1	17.2	73.5	5.2	22.3	1.0	4.2
	T2	10.9	65.6	4.1	24.5	1.6	9.9
	T3	9.9	64.4	4.4	28.6	1.1	7.0
	Study Mean	*12.7*	*67.8*	*4.6*	*25.1*	*1.2*	*7.0*

Saturated Fat	Test Period	Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	20.8	64.1	9.9	30.6	1.7	5.3
	T2	25.7	74.4	5.8	16.9	3.0	8.7
	T3	24.7	73.3	7.8	23.3	1.1	3.3
	Study Mean	*23.7*	*70.6*	*7.8*	*23.6*	*1.9*	*5.8*
B Ration Group (*n*=34)	T1	20.3	60.2	11.0	32.7	2.4	7.1
	T2	19.6	59.3	9.0	27.2	4.5	13.5
	T3	14.3	52.9	11.1	41.0	1.6	6.0
	Study Mean	*18.1*	*57.3*	*10.4*	*33.6*	*2.9*	*8.9*

Cholesterol	Test Period	Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	318	81.1	67	17.1	7	1.8
	T2	303	80.2	43	11.3	32	8.5
	T3	349	86.0	52	12.8	5	1.2
	Study Mean	*323*	*82.4*	*54*	*13.7*	*15*	*3.8*
B Ration Group (*n*=34)	T1	455	85.1	65	12.1	15	2.8
	T2	455	84.1	50	9.2	36	6.7
	T3	307	79.1	64	16.5	17	4.4
	Study Mean	*406*	*82.8*	*60*	*12.6*	*23*	*4.6*

Table 4.5 (Continued). Absolute intake and proportion of total nutrient intake by source.

Sodium	Test Period	Food Source					
		Galley		MRE		Pogey Bait	
		g/day	% of total	g/day	% of total	g/day	% of total
T Ration Group (*n*=17)	T1	3395	72.3	1152	24.5	144	3.1
	T2	3099	74.2	807	19.3	268	6.4
	T3	3007	74.8	909	22.6	103	2.6
	Study Mean	*3167*	*73.8*	*965*	*22.1*	*172*	*4.0*
B Ration Group (*n*=34)	T1	4263	73.2	1343	23.1	216	3.7
	T2	3807	75.2	922	18.2	331	6.5
	T3	3224	72.1	1073	24.0	173	3.9
	Study Mean	*3764*	*73.5*	*1113*	*21.8*	*240*	*4.7*

Calcium	Test Period	Food Source					
		Galley		MRE		Pogey Bait	
		g/day	% of total	g/day	% of total	g/day	% of total
T Ration Group (*n*=17)	T1	697	77.7	170	19.0	30	3.5
	T2	1109	86.3	117	9.1	60	4.7
	T3	930	84.9	141	12.9	24	2.2
	Study Mean	*912*	*83.0*	*143*	*13.7*	*38*	*3.5*
B Ration Group (*n*=34)	T1	1052	81.3	195	15.0	48	3.7
	T2	1028	80.7	160	12.5	86	6.8
	T3	715	75.3	185	19.4	50	5.2
	Study Mean	*932*	*79.1*	*180*	*15.6*	*61*	*5.2*

Magnesium	Test Period	Food Source					
		Galley		MRE		Pogey Bait	
		g/day	% of total	g/day	% of total	g/day	% of total
T Ration Group (*n*=17)	T1	217	67.5	79	24.7	25	7.8
	T2	212	68.7	52	16.8	45	14.4
	T3	207	73.3	59	20.8	16	5.8
	Study Mean	*212*	*69.8*	*63*	*20.8*	*29*	*9.3*
B Ration Group (*n*=34)	T1	283	71.4	84	21.3	29	7.3
	T2	251	69.7	66	18.5	43	11.8
	T3	218	65.7	80	24.3	33	10.0
	Study Mean	*251*	*68.9*	*77*	*21.4*	*35*	*9.7*

Table 4.5 (Continued). Absolute intake and proportion of total nutrient intake by source.

Zinc	Test Period	Food Source: Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	11.5	70.7	3.5	21.5	1.3	7.8
	T2	11.0	72.5	2.4	16.1	1.7	11.4
	T3	10.3	75.6	3.1	22.8	0.2	1.7
	Study Mean	*10.9*	*72.9*	*3.0*	*20.1*	*1.1*	*7.0*
B Ration Group (*n*=34)	T1	9.1	67.0	3.6	26.9	0.8	6.1
	T2	9.6	64.8	2.9	19.8	2.3	15.5
	T3	7.3	60.2	3.4	28.1	1.4	11.8
	Study Mean	*8.7*	*64.0*	*3.3*	*24.9*	*1.5*	*11.1*

Folate	Test Period	Food Source: Galley g/day	Galley % of total	MRE g/day	MRE % of total	Pogey Bait g/day	Pogey Bait % of total
T Ration Group (*n*=17)	T1	163	68.8	36	15.0	38	16.2
	T2	148	67.6	24	10.7	48	21.7
	T3	148	79.3	28	15	10	5.6
	Study Mean	*153*	*71.9*	*29*	*13.6*	*32*	*14.4*
B Ration Group (*n*=34)	T1	258	81.7	38	12.1	19	6.2
	T2	214	73.2	30	10.2	49	16.6
	T3	176	69.1	35	13.7	44	17.2
	Study Mean	*216*	*74.7*	*34*	*12.0*	*37*	*13.3*

Galley foods also accounted for most of the higher intakes of sodium ($p \leq 0.05$), magnesium ($p \leq 0.05$), and folate ($p \leq 0.001$) observed in the B Ration group, since absolute intakes of these nutrients from MREs and pogey bait were similar for both groups. Folate was the only nutrient that pogey bait provided in a greater proportion of total intake than energy. Although pogey bait contributed a mean of 8.4% of total energy intake in the T Ration group, it provided 14.4% of the total folate intake in this group. Likewise, pogey bait provided 11.1% of the energy consumed by the B Ration group, but it contributed 13.3% of the folate intake. MREs provided a much lower proportion of total folate intake (overall 12.5%) than they did for energy (21.8% of total energy intake).

The T Ration group obtained significantly more saturated fat from the galley (23.7 g) than did the B Ration group (18.1 g). The source distribution of saturated fatty acids (SFA) was significant ($p \leq 0.005$) and was very similar to that of total energy in the T Ration group, however; the B Ration group derived a proportionately greater amount of saturated fatty acids from the MRE than they did energy. The T Ration group obtained 70.6% of their SFA and 69.4% of their dietary energy from galley foods and 23.6% of SFA and 22.2% of total energy from the MRE. The B Ration group obtained 57.3% of their SFA and 65.1% of their energy from galley foods and 33.6% of their SFA, but only 23.7% of their energy from the MRE.

Meal Contributions

Intakes of energy and select nutrients during each meal were also analyzed. Breakfast and dinner intakes constituted food and beverage consumption visually estimated by dietary data collectors. Lunch and snack intake comprised all food and beverages recorded by the test volunteers on their food records: MRE components, pogey bait, and anything obtained from the mess tent but not consumed with breakfast or dinner, such as fresh fruit (when available), bulk beverages, or shelf-stable bread.

An ANOVA revealed that, overall, dinner for the T Ration group provided a significantly greater amount of energy (925 kcal) than breakfast (796 kcal) or lunch and snacks (845 kcal), while in the B Ration group, lunch and snack foods (1099 kcal) contributed significantly more energy than did breakfast (803 kcal) or dinner (965 kcal) ($p \leq 0.001$). By the third test period, those consuming the T Ration had significantly ($p \leq 0.03$) reduced their absolute energy intake at breakfast, but increased their energy intake at dinner. These results are shown more completely in Table 4.6.

Table 4.6. Absolute and proportional intakes of energy by meal.

	Test Period	Food Source: Breakfast kcal/day	Breakfast % of total	Lunch/Snack kcal/day	Lunch/Snack % of total	Dinner kcal/day	Dinner % of total
T Ration Group (n=17)	T1	841	31.2	966	35.9	887	32.9
	T2	824	31.8	817	31.6	948	36.6
	T3	722	30.0	753	31.2	940	38.9
	Study Mean	*796*	*31.0*	*845*	*32.9*	*925*	*36.0*
B Ration Group (n=34)	T1	957	30.4	1109	35.9	1028	33.2
	T2	818	29.1	1064	37.8	931	33.1
	T3	633	23.5	1124	41.8	935	34.7
	Study Mean	*803*	*28.0*	*1099*	*38.3*	*965*	*33.6*

Because of the decline in total energy intakes, the proportional contributions of each meal toward total energy intakes did not exhibit the same patterns of change between test periods as did those for absolute energy intakes. In the T Ration group, breakfast contributed a relatively constant proportion of the total energy intake during all three test periods (31.0%), whereas dinner provided progressively more of the energy consumed during each subsequent test period. During T1, T2, and T3, respectively, the T Ration group obtained 32.9%, 36.6%, and 38.9% of their declining caloric intake from dinner. The percentage of energy consumed with lunch and snacks by the T Ration group declined from T1 (35.9%) to T2 (31.6%), but remained constant from T2 to T3 (31.2%).

The B Ration group maintained a fairly constant percentage (33.6%) of total energy consumed at dinner during all three test periods, but exhibited a significant decrease in the proportion of total energy consumed at breakfast and an increase in the percentage contributed by lunch and snacks as the study progressed. Mean energy intakes of the B Ration group at breakfast represented 30.4%, 29.1%, and 23.5% of the total during T1, T2, and T3, respectively. Energy intakes in the B Ration group from lunch and snacks increased from 35.9% to 37.8% to 41.8% of total energy consumption.

Lunch and snacks were the greatest source of carbohydrate (40.4% of total average intake by all subjects used in the repeated measures analyses) ($p \leq 0.03$). Post hoc analyses confirmed ($p \leq 0.05$) that the slightly greater absolute carbohydrate intake in the B Ration group compared to the T Ration group was solely due to intake from lunch and snack foods; mean carbohydrate intakes at breakfast and dinner were very similar for the two groups.

Dinner was the greatest source of protein (41.6% of total average intake for the entire study). The absolute and proportional intakes of protein at each meal during the first test period were quite similar for the two ration groups. By the end of the study, meal distributions were significantly different ($p \leq 0.02$) between test groups. During the third test period, the T Ration group derived more of their protein from breakfast and dinner than did the B Ration group, while the B Ration group consumed a significantly greater percentage of their protein intake from lunch and snacks than the T Ration group. Protein intakes at dinner increased during the study—from 40.6 g (39.3% of total intake) to 38.7 g (40.3% of total) to 46.8 g (49.0%) ($p \leq 0.05$) in the T Ration group and, more modestly, from 41.8 g (38.2% of total intake) to 44.4 g (41.0% of total) to 42.2 g (44.4% of total) in the B Ration group. Conversely, absolute and proportional intakes of protein at breakfast declined over the three test periods ($p \leq 0.05$)—from 31.7 g (30.7% of total intake) to 29.6 g (30.8% of total) to 26.8 g (28.2% of total) in the T Ration group and from 33.3 g (30.4% of total intake) to 30.8 g (28.5% of total) to 20.8 g (21.9% of total) in the B Ration group.

Fat intake was greatest at breakfast in the T Ration group (36.2% of total fat intake), but was greatest at lunch and snacks for the B Ration group (35.4% of total fat intake). Fat intake at breakfast started out higher in the B Ration group than the T Ration group, but significantly ($p \leq 0.002$) declined over the course of the three test periods, from 46.4 g (36.8% of total intake) to 37.7 g (33.0% of total) to 26.5 g (25.9% of total). By the third test period, breakfast provided a lower absolute and proportional amount of fat in the B Ration group than the T Ration group.

Descriptive Statistics For Men and Women Completing Any Phase

Tables 4.7 and 4.8 present the nutrient intakes of all male volunteers while Tables 4.9 and 4.10 present the nutrient intakes of all female volunteers with useable data for any test period, regardless of whether they remained in the study or in their original test group for all three test periods. The changing number of volunteers in the ration groups during the three test periods reflects volunteers who dropped, switched from the T to the B group, or failed to provide useable dietary data for that test period. The 64 men who provided reportable dietary data for descriptive analyses weighed 79.6 ± 9.7 kg and had a BMI of 24.9 ± 2.5, while the 5 women in the study weighed 65.9 ± 9.2 kg and had a BMI of 22.2 ± 1.7 at the start of the study.

Table 4.7. Nutrient intakes of male volunteers completing any study test period.[1]

Nutrient	MRDA[2]	TEST PERIOD					
		T1		T2		T3	
		Assigned Test Group		Assigned Test Group		Assigned Test Group	
		T (n=28)	B (n=36)	T (n=22)	B (n=37)	T (n=18)	B (n=39)
Energy (Kcal)	*2800-3600*	2584 ± 518	3118 ± 559	2500 ± 522	2798 ± 636	2420 ± 432	2710 ± 641
Kcal per kg body weight	*na*	31.1 ± 7.6	40.3 ± 7.7	29.5 ± 7.3	35.3 ± 8.3	29.9 ± 7.6	36.6 ± 8.6
Carbohydrate (g)	*na*	332 ± 76	398 ± 73	301 ± 84	345 ± 81	281 ± 60	345 ± 81
Protein (g)	*100*	98 ± 22	110 ± 26	94 ± 21	108 ± 25	97 ± 20	95 ± 26
Protein per kg body weight	*[0.8-1.5]*	1.22 ± .032	1.41 ± 0.36	1.18 ± .028	1.38 ± 0.33	1.27 ± 0.29	1.26 ± 0.33
Fat (g)	*na*	99 ± 23	127 ± 28	102 ± 22	114 ± 32	96 ± 24	104 ± 30
Alcohol (g)	*na*	0.0	0.0	0.0	0.0	4.8 ± 8.4	7.8 ± 10.3
Fiber (g)	*(25+)*	17.9 ± 4.9	23.5 ± 5.4	14.2 ± 5.2	16.7 ± 4.3	13.5 ± 3.9	15.3 ± 4.2
Cholesterol (mg)	*(≤300)*	359 ± 129	539 ± 127	369 ± 134	524 ± 170	403 ± 135	390 ± 155
Saturated fatty acids (g)		30.0 ± 9.9	33.9 ± 11.6	33.2 ± 10.1	33.3 ± 11.8	32.9 ± 11.0	28.1 ± 11.0
Monounsaturated fatty acids (g)		35.1 ± 8.0	36.7 ± 9.6	34.6 ± 8.0	33.7 ± 11.2	34.5 ± 8.7	31.4 ±10.2
Polyunsaturated fatty acids (g)		16.2 ±4.6	14.5 ± 4.4	14.4 ± 3.7	11.4 ± 4.4	15.4 ± 5.6	12.3 ± 5.3
Vitamin A (μg RE)	*1000*	1253 ± 570	1698 ± 657	978 ± 366	1364 ± 644	1067 ± 372	1254 ± 636
Carotene (μg RE)	*na*	399 ± 213	576 ± 315	196 ± 63	471 ± 234	381 ± 178	244 ± 133
Folate (μg)	*400*	239 ± 134	315 ± 77	208 ± 91	288 ± 146	185 ± 50	251 ± 127

Table 4.7 (Continued). Nutrient intakes of male volunteers completing any study test period.[1]

Nutrient	MRDA[2]	TEST PERIOD					
		T1		T2		T3	
		Assigned Test Group		Assigned Test Group		Assigned Test Group	
		T (n=28)	B (n=36)	T (n=22)	B (n=37)	T (n=18)	B (n=39)
Thiamin (mg)	*1.6*	2.3 ± 0.7	3.0 ± 0.9	2.0 ± 0.6	2.6 ± 1.0	1.9 ± 0.6	3.0 ± 1.1
Niacin (mg)	*21*	27.1 ± 7.6	28.1 ± 6.7	22.9 ± 7.3	27.8 ± 10.2	25.0 ± 5.8	28.2 ± 10.4
Riboflavin (mg)	*1.9*	2.5 ± 0.9	2.9 ± 0.8	2.6 ± 0.9	2.8 ± 1.0	2.4 ± 0.8	2.4 ± 0.8
Vitamin B_6 (mg)	*2.2*	5.0 ± 11.4	3.1 ± 1.1	2.0 ± 0.6	2.4 ± 0.9	2.4 ± 0.7	2.6 ± 1.0
Vitamin C (mg)	*60*	171 ± 88	224 ± 92	92 ± 49	143 ± 65	99 ± 52	153 ± 87
Vitamin E (mgαTE)	*10*	14.6 ± 5.2	13.3 ± 3.5	11.5 ± 5.2	12.4 ± 7.6	11.9 ± 3.6	12.0 ± 6.7
Calcium (mg)	*800*	872 ± 440	1299 ± 510	1165 ± 550	1264 ± 549	1056 ± 556	976 ± 456
Iron (mg)	*10*	17.9 ± 6.6	20.5 ± 4.8	16.8 ± 5.2	18.8 ± 7.8	13.7 ± 2.6	16.5 ± 7.2
Magnesium (mg)	*350*	318 ± 75	395 ± 89	297 ± 75	356 ± 86	283 ± 66	329 ± 83
Potassium (mg)	*1875-5625*	3231 ± 770	4144 ± 918	2983 ± 790	3475 ± 846	2906 ± 637	2985 ± 787
Sodium (mg)	*~5500*	4546 ± 841	5873 ± 1278	4182 ± 810	5072 ± 1175	3927 ± 878	4492 ± 1238
Sodium (mg/1000 kcal)	*1400-1700*	1755 ± 170	1888 ± 297	1704 ± 297	1831 ± 288	1632 ± 278	1662 ± 207
Zinc (mg)	*15*	15.9 ± 4.8	13.6 ± 3.2	14.7 ± 4.2	14.8 ± 6.2	13.4 ± 3.0	12.1 ± 5.4

[1]Excludes test subjects who switched test groups during a study phase and the five female subjects
[2]Values in brackets are recommendations in current scientific literature. Values in parentheses are national health organization recommendations.

Table 4.8. Macronutrient distribution of male volunteers completing any study test period.[1]

Percent Energy:	Recommended	TEST PERIOD					
		T1		T2		T3	
		T (n=28)	B (n=36)	T (n=22)	B (n=37)	T (n=18)	B (n=39)
Carbohydrate	*50-55%*[2]	50.9 ± 4.9	49.6 ± 4.9	47.0 ± 5.7	48.5 ± 5.4	45.6 ± 6.5	50.4 ± 4.3
Protein	*12-15%*	15.2 ± 1.8	14.0 ± 1.8	14.7 ± 2.4	15.7 ± 2.1	16.6 ± 2.4	13.8 ± 1.4
Fat	*≤35%*	34.1 ± 3.6	36.1 ± 3.4	36.7 ± 3.8	35.8 ± 4.0	35.2 ± 5.3	33.6 ± 3.7
Alcohol	*na*	0.0	0.0	0.0	0.0	0 ± 2.3	0.1 ± 3.0
Monounsaturated fat	*≥10%*	12.6 ± 1.6	10.6 ± 1.5	12.4 ± 1.5	10.4 ± 1.8	12.5 ± 2.2	10.2 ± 1.9
Polyunsaturated fat	*na*	5.7 ± 1.1	4.2 ± 0.9	5.2 ± 0.8	3.6 ± 0.9	5.7 ± 1.6	4.0 ± 1.5
Saturated fat	*≤10%*	10.4 ± 2.2	9.6 ± 2.3	11.9 ± 2.0	10.5 ± 2.4	12.1 ± 3.1	9.1 ± 2.3

[1]Excludes test subjects who switched test groups during a study phase and the five female subjects.
[2] Recommended for general health. Recommendations for physically active individuals and athletes are usually to have carbohydrates provide 60%-70% of calories.

Table 4.9. Nutrient intakes of female volunteers completing any study test period.

Nutrient	MRDA*	TEST PERIOD					
		T1		T2		T3	
		Assigned Test Group		Assigned Test Group		Assigned Test Group	
		T (*n*=3)	B (*n*=2)	T (*n*=1)	B (*n*=4)	T (*n*=0)	B (*n*=5)
Energy (Kcal)	*2000-2800*	2421 ± 32	2443 ± 514	2145	2229 ± 189	–	2086 ± 300
Kcal per kg Body Weight	*na*	36.7 ± 2.0	37.5 ± 2.3	34.9	33.6 ± 3.3	–	32.9 ± 5.7
Carbohydrate (g)	*na*	361 ± 22	328 ± 73	328	308 ± 22	–	263 ± 33
Protein (g)	*80*	65 ± 5.2	81 ± 28	48	66 ± 17	–	68 ± 18
Protein per kg body weight	*[0.8-1.5]*	0.98 ± 0.03	1.22 ± 0.10	0.78	0.98 ± 0.14	–	1.06 ± 0.23
Fat (g)	*na*	85 ± 13	95 ± 13	74	85 ± 12	–	82 ± 12
Alcohol (g)	*na*	0.0	0.0	0.0	0.0	–	7.3 ± 5.0
Fiber (g)	*(25+)*	19 ± 3	21 ± 5	11	14 ± 3	–	12 ± 3
Cholesterol (mg)	*(≤300)*	174 ± 79	286 ± 90	163	223 ± 47	–	264 ± 40
Saturated fatty acids (g)		27.1 ± 7.7	19.2 ± 4.1	26.5	20.1 ± 6.5	–	21.8 ± 4.9
Mono-unsaturated fatty acids (g)		32.1 ± 3.5	27.7 ± 6.5	23.9	24.5 ± 3.7	–	26.2 ± 7.3
Polyunsaturated fatty acids (g)		13.8 ± 4.1	13.4 ± 3.5	9.1	11.5 ± 3.0	–	10.3 ± 4.3
Vitamin A (μg RE)	*800*	1825 ± 1450	849 ± 93	1358	1180 ± 909	–	1123 ± 1045
Carotene (μg RE)	*na*	159 ± 165	235 ± 72	171	242 ± 74	–	107 ± 47
Folate (μg)	*400*	161 ± 36	244 ± 103	125	184 ± 50	–	162 ± 26

Table 4.9 (Continued). Nutrient intakes of female volunteers completing any study test period.

Nutrient	MRDA	TEST PERIOD					
		T1		T2		T3	
		Assigned Test Group		Assigned Test Group		Assigned Test Group	
		T (*n*=3)	B (*n*=2)	T (*n*=1)	B (*n*=4)	T (*n*=0)	B (*n*=5)
Thiamin (mg)	*1.2*	3.1 ± 1.8	2.3 ± 0.3	2.4	2.5 ± 0.8	–	2.3 ± 1.2
Niacin (mg)	*16*	19.4 ± 4.5	25.0 ± 8.6	16.4	21.7 ± 5.9	–	21.5 ± 6.3
Riboflavin (mg)	*1.4*	2.0 ± 0.5	1.7 ± 0.2	1.4	1.8 ± 0.3	–	1.5 ± 0.3
Vitamin B_6 (mg)	*2.0*	3.7 ± 2.3	2.2 ± 0.5	2.3	2.2 ± 1.4	–	2.3 ± 1.6
Vitamin C (mg)	*60*	122 ± 125	174 ± 6	161	132 ± 49	–	98 ± 63
Vitamin E (mgαTE)	*8*	9.8 ± 1.4	13.0 ± 1.3	11.0	11.2 ± 1.3	–	7.7 ± 2.4
Calcium (mg)	*800*	808 ± 411	477 ± 14	659	616 ± 250	–	513 ± 149
Iron (mg)	*18*	13.8 ± 2.7	17.4 ± 4.8	12.3	15.0 ± 2.8	–	12.2 ± 2.3
Magnesium (mg)	*300*	291 ± 32	295 ± 110	191	240 ± 51	–	222 ± 51
Potassium (mg)	*1875-5625*	2777 ± 422	2791 ± 736	1656	2391 ± 517	–	2186 ± 548
Sodium (mg)	*~4100*	3335 ± 571	4305 ± 1007	2984	4122 ± 805	–	3582 ± 823
Sodium (mg/1000 kcal)	*1400-1700*	1377 ± 233	1758 ± 42	1392	1846 ± 292	–	1712 ± 282
Zinc (mg)	*15*	9.9 ± 1.9	10.2 ± 4.0	6.9	7.7 ± 1.9	–	8.17 ± 1.6

*Values in brackets are recommendations in current scientific literature. Values in parentheses are national health organization recommendations.

Table 4.10. Macronutrient distribution of female volunteers completing any study test period.

Percent Energy:	% Recommended	TEST PERIOD					
		T1		T2		T3	
		T (n=3)	B (n=2)	T (n=1)	B (n=4)	T (n=0)	B (n=5)
Carbohydrate	*50%-55%*[1]	58.6 ± 4.2	52.7 ± 0.7	60.4	54.7 ± 4.2	–	50.0 ± 1.9
Protein	*12%-15%*	10.5 ± 0.8	12.8 ± 1.8	8.8	11.6 ± 2.6	–	12.8 ± 2.3
Fat	*≤30%*	30.9 ± 4.4	34.5 ± 2.5	30.8	33.7 ± 2.1	–	34.8 ± 1.4
Alcohol	*na*	0.0	0.0	0.0	0.0	–	2.4 ± 1.6
Mono-unsaturated fat	*≥10%*	11.7 ± 1.2	10.0 ± 0.2	9.9	9.7 ± 1.4	–	11.0 ± 1.4
Polyunsaturated fat	*na*	5.0 ± 1.5	4.8 ± 0.2	3.8	4.6 ± 1.1	–	4.3 ± 1.3
Saturated fat	*≤10%*	9.9 ± 2.8	6.9 ± 0.0	11.0	7.9 ± 2.1	–	9.2 ± 1.1

[1]Recommended for general health. Recommendations for physically active individuals and athletes are usually to have carbohydrates provide 60%-70% of calories.

DISCUSSION

Operational rations are designed to be nutritionally adequate for most military personnel, but only if they are consumed as intended. Underconsumption of operational rations is common (1). Modest, short-term deficits in energy and most nutrients are well-tolerated. But as the period of underconsumption progresses, or the magnitude of deficiency increases, performance and health can deteriorate (8,11,14).

Provision of hot meals has been documented to improve ration consumption in the field (1,15). As already mentioned, provision of cook-prepared meals are not feasible in many combat or deployment situations. T Rations are an efficient way to provide group hot meals without the need for specially trained cooks or kitchen equipment. Acceptability and consumption of rations are affected by meal schedules, the appropriateness of the menu selections to the time of day, variety, serving temperatures, how the food looks, and the attitude of the server.

This study was able to evaluate T Rations in a realistic operational setting that exhibited some typical field feeding problems, such as incomplete delivery or substitution of menus and menu items, kitchen staff with limited field experience, and equipment breakdown. The following sections of the discussion describe the impact of B and T Ration meals on overall energy intake and the relative abilities of these feeding systems to meet dietary recommendations for specific macro- and micronutrients.

Energy

The results of this study show that Marines consuming two T Rations along with one MRE per day for 60 days consumed significantly less energy (294 kcal/day) than those subsisting on two B Rations and one MRE per day. The difference in energy intake between test groups was greatest during the first test period and decreased during subsequent test periods because of a greater decline in energy intake in the B Ration group than the T Ration group.

Average energy intakes in the T Ration group did not reach the minimum 2800 kcal MRDA for energy during any test period. Although energy intakes in the B Ration group started out within the energy allowance range during the first test period, they barely met the minimum MRDA for energy during the second test period and failed to reach the lowest energy allowance figure by the third test period. Mean daily energy intakes in the T Ration group were 29.5 to 31.1 kcal/kg body weight, depending on test period, whereas the energy expenditure data presented in Chapter 6 indicate that the daily energy requirements of the Marines on this deployment were on the order of 42 kcal/kg. Resting daily energy expenditures are approximately 25 kcal/kg, while the daily energy needs of men performing light activity are about 38 kcal/kg. Moderately active men require about 41 kcal/kg, while men engaged in heavy activity need approximately 50 kcal/kg (13) to maintain their body weight. Although mean energy intakes per kg body weight of volunteers in the B Ration group (35.3 to 40.3 kcal/kg, depending on test period) were much better than those of the T Ration group, they were still only adequate to support light to moderate levels of physical activity if body weight were to be maintained.

The relative stability in energy intakes across the three test periods in the T Ration group may be a reflection of the relative consistency in quality of the T Ration. Although the T Ration was not as well received as the B Ration (see Chapter 10), it consistently met the expectations of these Marines. In other words, they may have gone into the study expecting to be dissatisfied and they were. The finding that the Marines consuming the T Ration did not compensate for their low intake of T Ration foods by increasing intake of MRE or pogey bait foods is consistent with a general dissatisfaction with the feeding situation and agrees with the generally lower acceptability ratings of MRE items by the T Ration group (i.e., a "halo" effect).

The large decline in energy intakes in the B Ration group was due entirely to decreased intakes of galley foods. This may reflect the observed decline in quality of the B Ration as ingredients ran out or deteriorated during storage and the cooks tired. The quality of the B Rations seemed to drop over the course of the study. This was likely because they were left in the storage containers, while early in the deployment, T Rations were pulled from the storage containers, placed on pallets, and covered. Unlike the T Ration group, the B Ration group slightly compensated for their lesser intake of galley foods by consuming a little more energy from MREs and pogey bait during the third test period. Contrary to what was expected, the B ration group consumed more calories from non-galley foods than the T Ration group during all three test periods.

While the B Ration system allows for greater menu variety than the T Ration, not all B Ration menus or menu choices were available to these Marines. According to the mess chief, he had not seen the B Ration menus nor was he involved in ordering the food for the deployment. One of the ingredients that was unavailable during the deployment was dehydrated vinegar, which the mess chief said he had never seen, although it is included in several B Ration recipes. Still, the B Ration menus served during this study did provide more food selections than the T Ration, which may account for some of their caloric advantage.

There were several sources of non-ration foods (pogey bait) available on the island. According to most Marines queried, such availability of non-ration foods is fairly common. However pogey bait made up relatively small percentages of total intakes (8.4%–11.0%). Most of the Marines had limited funds for purchase of outside foods, especially during the first test period because paychecks had not arrived. Whereas consumption of ration foods may have been higher had these outside foods not been available, it seems there are almost always non-ration foods competing with the military rations.

Overall energy intakes in the T Ration group were lower than recommended and less than what has been found during previous studies in which two T Rations and one MRE were provided, despite improvements in the rations (see Table 4.11). However the mean energy intake of the T Ration group during the first test period is comparable to those reported for shorter field studies. In the CFFS study conducted in 1985, volunteers receiving two T Rations and one MRE per day consumed an average of 2725 kcal on the 12 data collection days within the 36-day feeding period (21) . A similar group receiving two T Rations and one MRE had almost identical energy intakes which subsequently increased almost 200 kcal/day when they received A- and B-Ration enhancements.

Table 4.11. Summary of energy intakes of previous ration field studies.

STUDY	Ration	Duration	Energy Intake (kcal/day)
USARIEM/USACDEC (CFFS), 1986	2 T Rations + 1 MRE	36 Days	2725
Salter et al., 1991	2 FY 89 T Rations + 1 MRE	14 Days	2880
Salter et al., 1991	2 FY90 T Rations + 1 MRE	14 Days	2884
Kramer et al., 1993	2 FY90 T Ration + 1 MRE	7 Days	3174
Kramer et al., 1993	2 FY90 T Ration and 5 New Menus + 1 MRE	7 Days	2657
Cline and McGraw, 1997	UGR (T&B)	10 Days	2631
USARIEM/USACDEC (CFFS), 1986	2 B Rations + 1 MRE	40 Days	2760
Edinberg and Engell, 1988	2 B Rations + 1 MRE (Pogey Bait Not Recorded)	4 Days	2201
Edwards et al., 1991	2 B Rations	15 Days at Altitude	2140
Thomas et al., 1995	3 MREs	30 Days	2445
Thomas et al., 1995	2 A Rations + 1 MRE	30 Days	2900
Rose and Carlson, 1986	3 A Rations	8 Days	3713

Abbreviations: **T Ration** - Tray Pack Ration
MRE - Meal Ready-to-Eat
A Rations - Fresh perishable and semi-perishable foods
UGR - Unitized Group Ration
B Rations - Canned and Dried Foods

There have been very few field studies of B Ration feeding with which to compare intakes in the current study. Forty days of subsistence on two B Rations and one MRE per day during the CFFS study gave rise to mean energy intakes of 2760 kcal/day—about 100 kcals less than in the current study. Unlike the Marines in the current study, volunteers in the CFFS study did not have access to pogey bait. Edinberg and Engell (6) conducted a four-day field evaluation of the B Ration in a hot weather environment. They reported a mean intake of 2201 kcal/day for the B Ration breakfast and dinner and the MRE lunch. The authors did not calculate total energy intakes which would have included contributions from pogey bait items. Pogey bait was not supposed to be allowed, but was consumed and reported by the volunteers. The B Ration group in the current study consumed a mean 2553 kcal/day from galley and MRE foods, well exceeding the energy intakes in the Edinberg and Engell (6) study.

Macronutrients and Fiber

General health promotion recommendations are for carbohydrates to contribute 55%-60% of total calories, protein to contribute 12%-15%, and fat to provide 30% or less of total energy in the diet. The 1985 MRDA allows a more generous contribution of total fat toward energy intake. Dietary recommendations for athletes and physically active individuals—which would describe many military members during combat or deployment—are for a greater proportion of carbohydrate (60%-70% of calories) with a concomitantly lesser proportion of fat (20%-25% of calories) to support daily replacement of body fuel stores—muscle and liver glycogen. Overall, neither ration group met these recommendations. The proportions of energy from carbohydrate were lower, and those from fat were higher than desirable, although this did not seem to be detrimental to performance or health during the 2-month period of the study.

Adequate dietary carbohydrate is important to maintain a high level of physical and mental performance. There is no MRDA for carbohydrate. Sports nutritionists (12) recommend a diet of at least 8 g/kg body weight per day for individuals working hard for several hours each day. This corresponds to a carbohydrate intake of 500–600 g per day or approximately 65% of total calories. A carbohydrate intake of 6 g/kg body weight per day is considered sufficient for persons exercising for 1 hour or less per day (3). This level would equate to about 400–500 g carbohydrate per day. Few volunteers in either ration group achieved carbohydrate intakes of even 6 g/kg per day. During the first test period, approximately 90% and 70% of all volunteers in the T Ration and B Ration groups, respectively, consumed less than 6 g carbohydrate per kg body weight. By the second test period, 90% of volunteers in both ration groups failed to meet this conservative goal, and by the third test period, no volunteer in the T Ration group and only four in the B Ration group consumed as much as 6 g carbohydrate per kg body weight.

Despite low energy intakes, mean protein intakes were close to the 100 gram MRDA and, even in the T Ration group, exceeded 1.2 g/kg body weight. This protein intake is estimated to be the amount needed to spare lean body mass during the concurrent energy deficit and moderate levels of physical activity (two conditions that increase protein requirements) noted during this study. Phinney (14) estimated that protein intakes of at least 1.0 g/kg body weight would likely protect loss of lean body mass during energy deficits induced by increased physical activity. Therefore, the seemingly high protein content of the rations may help to spare lean body mass and to prevent negative nitrogen balance when consumption is inadequate to meet energy needs. However, high protein intakes increase obligatory urinary water losses because of the excretion of nitrogenous waste. This conceivably could be detrimental in hot environments if potable water is not readily available. Consequently, the protein content of the diet should not be overly generous.

Mean fat consumption—as a percentage of total energy intake—slightly exceeded the levels recommended in the MRDA (35% of total calories), although greatly exceeded recommendations made by national health organizations and sports nutritionists (3,23). Overall, the T Ration group derived 35.8% of their calories from fat, while 35.7% of the calories consumed by the B Ration group came from fat. Since such high proportions of energy from fat could have moderated the observed energy deficits caused by reduced food intakes, they were not necessarily deleterious to health or performance. Saturated fatty acid intake was higher in the T Ration group than recommended, contributing 11.7% of the total energy intake compared to guidelines of no more than 10% of total calories.

Dietary fiber intakes, although never optimal, were higher during the first test period when more fresh fruit and a few salads were offered. This finding reinforces the importance of fresh fruit and vegetable enhancements to both T and B Ration feeding.

Micronutrients

Dietary intakes from both feeding systems were adequate for most vitamins and minerals evaluated, with the exception of folate in both ration groups, magnesium in the T Ration group and zinc in the B Ration group. The fairly generous intakes of thiamin, niacin, riboflavin, ascorbic acid, and iron reflect the fortification of select ration components. Although vitamin C intakes appear generous, they may in fact have been much lower because of deterioration of this nutrient in storage.

Folic acid intakes in both ration groups were well below desirable levels. Folic acid intakes of individuals consuming T Rations could have been improved if the orange juice that comes with the T Ration were actually served as often as it was provided; T Ration orange juice contains an estimated 40-45 μg folate per 8 fl. oz. serving. The T Ration juices were rarely provided because, according to the cooks, they required too much mixing to go into solution. Individual serving size cans of 100% juice were available with the B Ration, but were often not served because they had not been retrieved from distant storage. The mess sergeant seemed unaware and unconcerned that fruit juice was not provided at all breakfast meals.

The operational rations provided during this study, as well as the 1994 Survey Nutrient Database used to analyze the intake data, do not reflect the increase in folate content of enriched grain products, such as white bread and flour, pasta and rice, required by federal regulation as of January 1998. Thus some but not all of the folate deficits could be corrected if the ration manufacturers are required to follow these fortification regulations.

There currently is no MRDA for sodium; however, the regulation provides a recommended upper limit for food served in military food service systems of 1700 mg per 1000 kilocalories to promote sodium intakes under approximately 5500 mg for men and 4100 mg for women. National health promotion initiatives recommend sodium intakes of no more than 2500 mg per day for the primary prevention of hypertension. Although appropriate for the general population, this goal may be too low for military purposes. The Committee on Military Nutrition Research of the Food and Nutrition Board, Institute of Medicine recommended that total daily sodium intakes be limited to 4000 mg or less, except under conditions in which sodium losses would be high, such as those associated with heavy physical work in a hot environment (4). Given the hot tempertures and moderate to heavy physical labor performed during the deployment of the Marines studied, their sodium intakes—although higher than MRDA guidelines during the first two test periods—were probably not excessive. An important factor in this interpretation is that adequate potable (although not always palatable) water was available.

Breakfast continues to be the problem meal for both T Ration and B Ration feeding. Breakfasts were relatively high (data not presented) in cholesterol and low in carbohydrate and fiber. Meal attendance kept by the study "monitor" revealed that a large proportion of volunteers in the T Ration group (25%-50%) skipped breakfast when the data collection team was not on the island. Information is not available for the B Ration group for the days between the first and second test periods, but during the intervening days between the second and third test periods, a relatively smaller proportion of volunteers in the B Ration group (12%–30%) skipped breakfast.

Ration Supplements and Enhancements

Ration enhancements were not effectively utilized during this study. Because fresh produce was expensive and not always available on the island, few attempts were made to procure it. Apples and oranges were sporadically available, and salad was served only two days during the deployment because the ice machine broke and could not be repaired. The mess sergeant felt that salads would not hold up during meal service if not on ice. Salad dressing was not provided because it was not available when food supplies were ordered prior to deployment and was deemed to be too expensive to obtain on the island. Funds were available for local food purchases, but the mess sergeant was reluctant to spend them even towards the end of the deployment.

Hot sauce was the only condiment provided with the T Ration. Because relatively little was used, it is estimated that more than 75 bottles of hot sauce were discarded. Ketchup, which was available as a B Ration item, was rarely offered because, according to the mess sergeant, the large size can would have generated excessive waste, since there was not enough refrigerated storage to allow keeping it after opening.

Shelf stable bread was provided as a ration supplement, but it had a date of pack of November '94 (almost 3½ years prior to the study) and had been subjected to extreme storage conditions for at least the time of shipment and holding on the island. The quality had substantially deteriorated. The very low consumption of pouch bread was likely due to this factor. During the entire 18-day data collection period and for all subjects providing any dietary data (70–81,depending on the test period), only 108.4 servings of pouch bread were actually consumed. This would equate to less than one-tenth of one serving of bread per person for the entire study. Total energy and carbohydrate may have been better had the bread been more acceptable.

CONCULSIONS

- Marines consuming 2 T Rations along with one MRE per day for 60 days failed to consume the minimum MRDAs for energy, folate, magnesium, and zinc and did not achieve dietary recommendations for carbohydrate, dietary fiber, total fat, and saturated fat. Relative to the B Ration group, the T Ration group consumed, overall, less energy, carbohydrate, protein, dietary fiber, vitamin A, folate, thiamin, vitamin C, magnesium, and phosphorus.

- Based on this study's findings (especially that of low energy intakes), prolonged feeding of T Rations in the manner provided during this study cannot be advocated. With modification of the T Ration menu and enforcement of enrichment policies, the ration may prove to be adequate for Marines during extended deployments.

- Neither T nor B Rations fed exclusively for long periods of time appear advantageous. As has been recommended previously, a switch to A Rations as soon as logistically possible should be made.

- Trained food service personnel should be deployed even if T Rations are utilized to better ensure proper food storage, sanitation, insect and rodent control, food heating, and service. In addition, cooks would be able to provide soups and warming beverages.

- Provision of bulk, carbohydrate-containing beverages (either sugar-sweetened or sugar-maltodextrose combination) to enhance energy and carbohydrate intakes should be encouraged.

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CHAPTER 5

RATION ACCEPTABILITY

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INTRODUCTION

For the United States Marine Corps (USMC), the current standard practice of ration use while in the field is two B Ration meals and one Meal Ready-to-Eat (MRE) per day (ration descriptions have been described previously [16]). The B Ration requires kitchen facilities and trained food service personnel and provides a variety of foods including 10 breakfast menus, 10 lunch menus, and 10 dinner menus. It has been proposed that the USMC replace the B Ration with the Tray Pack Ration (T Ration; ration description has been described elsewhere [16]) since using the T Ration would allow for reductions in personnel (e.g., trained cooks) specialized equipment (e.g., stoves) and water for preparation and cleanup. However, the T Ration provides less variety, consisting of 10 breakfast menus and 10 lunch/dinner menus. Operational requirements suggest the USMC may need to consume T Rations for extended periods of time.

During Operation Desert Shield/Desert Storm there was often a lack of variety in the rations served regardless of the type of ration availble, raising the concerns of the military dietitians deployed there about the nutritional intake of troops (5). Monotony caused by repeated exposure to the same menu cycle may exacerbate the problem of underconsumption (4). A review of the literature (11) indicates that the palatability of staple foods (e.g., dairy products, bread, coffee) and items with initially high ratings (e.g., fruit, dessert) are less affected by repeated exposure, while the main components of a meal (i.e., the entree, meats, vegetables) become less desirable (14,15). In general, food preferences and reported frequencies of consumption are linked. Foods that are liked are eaten more often while those that are not liked are avoided (1). However, Drewnowski and Haan (1) also report that fruit and sweet desserts are eaten less often regardless of how good their acceptability scores are compared to entrees and other staple foods. In some of the only research done using acceptability ratings on repeated exposures to the same foods, it was observed that ratings of highly liked foods (a mean rating $\geq$ 7.00 on a Likert-type 9-point hedonic scale) did not change, while ratings declined for those foods that were less-liked (14). These studies and the anecdotal evidence seen during Desert Shield/Storm show the importance of having acceptable entrees in meeting the nutrient needs of military personnel. Since the entree and vegetable components of the rations are the most important in maintaining energy and nutrient requirements, it is especially important that these items are well-liked.

Both the T and B Rations have been evaluated for acceptability in the past. The information obtained from these studies helped guide ration developers in improving items and in seeking alternative ration items for those items that were rated poorly. The studies cited below all used the same 9-point hedonic scale discussed above to rate acceptability. For the purposes of this review, an item is considered to be liked if it has a mean rating of at least 6.0 ("like slightly"). A past evaluation of A, B and T Rations found that the A Ration had the highest percentage of liked entrees (81.0%; n = 21), while 31.3% of the T Ration entrees (n = 16) and 27.8% of the B Ration entrees were liked (n = 18) (17). Improvements in the development of new rations showed improvements in acceptability ratings as well. An evaluation of the B Ration (2) showed that 50.0% of the entrees (n = 16) were liked. An evaluation of the T Ration (13) also showed improvements in acceptability, as liked ratings were observed in 40.7% of the items of the Fiscal Year (FY) 1989 entrees (n = 27) and 45.5% of the FY 1990 entrees (n = 22). A later study (9) found that 50.0% of the entrees in the "new" FY 1990 version (n = 14) were well-liked. A recent evaluation (6) of the Unitized Group Ration (UGR) found that 80.0% of the B Ration entrees (n = 10) and 50.0% of the T

Ration entrees (n = 12) were well-liked. This 80% finding of "liked" foods of the B Ration entrees is comparable to 81% of the A Ration entrees during the 1986 study (17).

The main objective described in this chapter was to determine whether the acceptability of T Rations declines over time when consumed twice a day for 60 days. A secondary objective was to determine acceptablilty ratings relative to the ratings of similar B Ration foods. While cost and logistical issues are important when developing rations for extended field use, acceptability of the ration is also critical to maintain morale. Commanders need assurances that their soldiers or Marines are focused on their mission as opposed to spending their time grumbling about the food. Furthermore, during actual combat, supplemental foods from local sources may not be available. Therefore, those who do not eat the rations may be at even greater risk of nutritional deficiencies during combat or isolated deployments than when observed in ration tests during field training exercises.

METHODS

T and B Ration Acceptability

Ration acceptability data were collected during the three test periods T1, T2, and T3 (see Table 1.1 for actual days), at the same time dietary intakes (Chapter 4) were assessed. Volunteers were assigned randomly to either the T Ration or B Ration group for the duration of the study. Volunteers consumed a T or B Ration for breakfast and dinner and an MRE for lunch. Acceptability of food and beverage items for both the T and B Rations were measured using a 9-point hedonic scale, where 1 = "dislike extremely," 5 = "neither like nor dislike," and 9 = "like extremely." Both B and T Rations were served in the same field mess tent. Volunteers entered the mess tent in one chow line which then divided into two (T Rations were served on the left and B Rations on the right). The two ration groups ate their breakfast and dinner meals at the same time and place. Volunteers were handed 1 page rating sheets at the time they had their meals visually estimated. These rating sheets were turned in along with any meal leftovers immediately after consuming their meal.

The mess sergeant determined which T and B Ration menus were served each day. The presentation of the menus varied but did not follow any preset menu cycle. Actual daily menus served are shown in the Appendix. Optimum menu rotation or variation was not possible, in part because of logistical limitations. The Defense Supply Center Philadelphia (DSCP) either did not deliver some items or substituted menus or menu items. In addition, menus or menu items were inaccessible in the storage container due to the way rations were palletized and loaded for shipment to the island. The daily menus were often determined by what food was easiest to retrieve from the storage van.

A total of 59 volunteers (21 in the T Ration Group and 38 in the B Ration Group) completed ration acceptability forms. The acceptability data for each volunteer were checked against their intake data for that meal to ensure that the volunteer actually ate the items rated. Those items which were rated but had no intake data associated with them were dropped. Ratings of ration items for the other group to which a volunteer was assigned were not used. The breakfast meal for 3 May (T2) was dropped because the Marines were not served the test rations for that meal.

The data were aggregated so that each volunteer had an average rating per food item per test period. In this way, the data were controlled for the number of times a volunteer ate a particular item. The data were also aggregated so that each volunteer had an average rating per food category (e.g., breakfast meat, dinner vegetables, etc.) per test period. This second aggregation into food categories was necessary, since individual items in the T ration do not directly correspond to individual items in the B ration. Common food items (i.e., items that are identical for both ration groups) include white and chocolate milk, fruit drink, juice, oatmeal, fresh fruit, coffee, cocoa, pouch bread, peanut butter, and jelly. Common food items were analyzed as part of the meal they were served with. For example, milk was analyzed separately depending on whether it was served with the breakfast or the dinner meal. Data were analyzed using repeated measures analyses of variance (ANOVA) for each of the food categories by test period (within factor) and ration group (between factor). Post-hoc paired t-tests determined location of significant differences. When the test period by group interaction was not significant, subsequent analyses evaluated any effects across test periods regardless of ration group, as well as differences between the two ration groups regardless of test period.

Meal Ready-to-Eat (MRE) Acceptability

MRE logs were collected on a daily basis from both groups during each test period (T1, T2, T3). These logs provided feedback on the acceptability of the MRE components. The Marines rated the MRE items on the same 9-point hedonic scale used to rate the T and B rations (1 = "dislike extremely" 9 = "like extremely"). After data entry and verification, the data were aggregated so that each volunteer had one average rating per food item per test period.

Average MRE acceptability ratings were calculated for both individual ration items and for major food categories (e.g., entrees). ANOVAs were run to determine if the acceptability of the MRE differed between the two ration groups, changed from one test period to another, or had different patterns over the three test periods for the two groups. Although a repeated measures analysis would typically be used to evaluate patterns over time, a between-subjects analysis was used because many Marines did not eat items in each food category during each of the three test periods.

RESULTS

Ratings of T and B Breakfasts

Significant main effect acceptability ratings were observed between eggs (T Ration: 4.75 ± 2.25 vs. B Ration: 6.10 ± 1.76; $p < 0.05$) and fruit drink (T Ration: 5.67 ± 2.26 vs. B Ration: 6.96 ± 1.40; $p < 0.05$). A significant ration group by test period interaction effect ($p < 0.05$) existed for breakfast meats (Figures 5.1). Breakfast meats were rated similarly during T1, but B Ration meats were rated significantly higher at T2 and T3 ($p < 0.05$). Significant differences ($p < 0.05$) were observed across time for eggs, starches, cakes, and milk (Table 5.1 for mean ratings). These means are for those who gave ratings for all three test periods. There were no other group or interaction effects (note: for B Ration breakfast starches and T Ration cakes there were

Figure 5.1. Breakfast meat acceptability ratings: ration by test period interaction effect.

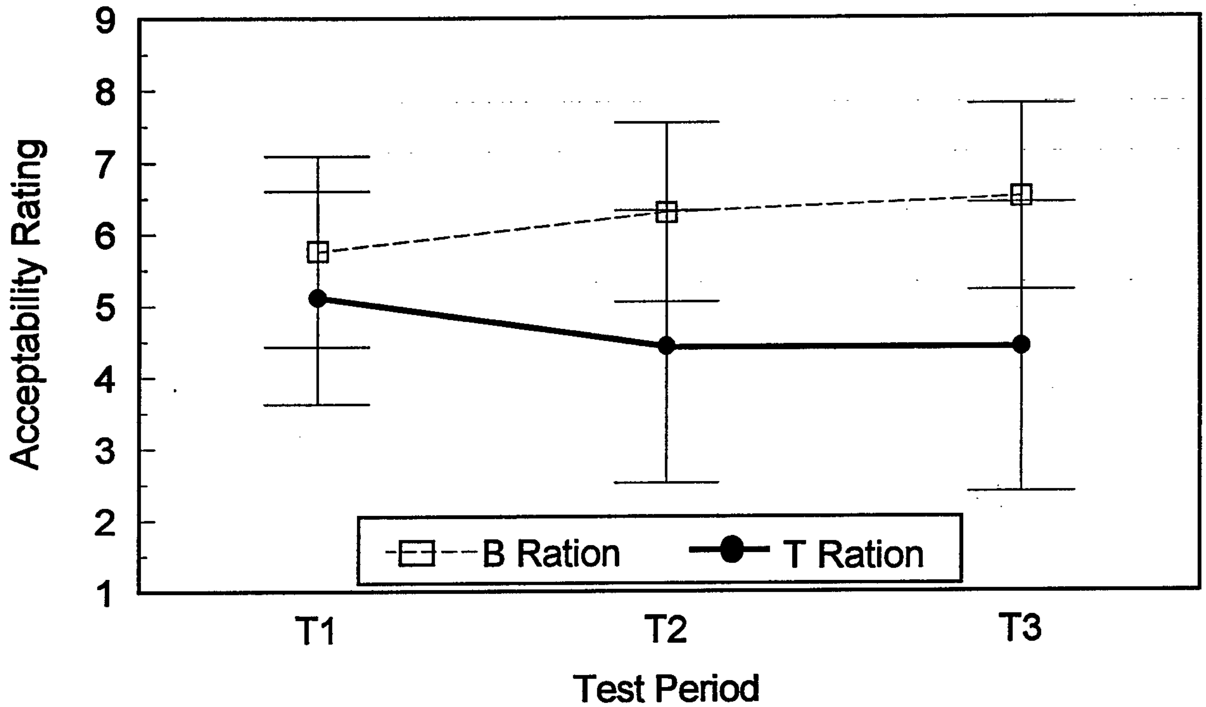

Table 5.1. Breakfast food category acceptabilities over time.

Food Category by Ration Group	T1		T2		T3	
	Mean ± S.D.	*n*	Mean ± S.D.	*n*	Mean ± S.D.	*n*
Eggs T Ration	5.23 ± 1.71	15	4.60 ± 2.64	15	4.43 ± 2.40	15
Eggs B Ration	6.43 ± 1.66	26	6.21 ± 1.96	26	5.66 ± 1.65	26
Meat T Ration	5.11 ± 1.49	17	4.42 ± 1.90	17	4.41± 2.02	17
Meat B Ration	5.76 ± 1.33	28	6.30 ± 1.25	28	6.51 ± 1.30	28
Fruit Drink T Ration	6.32 ± 2.33	12	5.56 ± 2.38	12	5.12 ± 2.07	12
Fruit Drink B Ration	6.88 ± 1.46	22	7.09 ± 1.39	22	6.90 ± 1.34	22
Milk T Ration	7.08 ± 1.31	12	6.52 ± 2.22	12	5.80 ± 2.28	12
Milk B Ration	7.56 ± 1.18	17	7.78 ± 1.10	17	6.96 ± 1.61	17
Starch T Ration	Not Served		Not Served		Not Served	
Starch B Ration	6.77 ± 1.24	23	5.83 ± 1.73	23	6.12 ± 1.54	23
Bread T Ration	Not Served		Not Served		Not Served	
Bread B Ration	6.57 ± 1.28	32	7.04 ± 1.11	32	6.90 ± 1.31	32
Cake T Ration	6.76 ± 1.24	13	5.79 ± 1.52	13	5.32 ± 1.66	13
Cake B Ration	Not Served		Not Served		Not Served	
Grits/Oatmeal T Ration	7.53 ± 0.96	6	6.89 ± 1.25	6	6.72 ± 7.88	6
Grits/Oatmeal B Ration	6.96 ± 1.31	14	6.07 ± 1.37	14	6.17 ± 1.50	14

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like Nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.

* Ratings for the various food categories represent averages of the various foods that comprise that category. If the same food (e.g., white milk) was available to both groups, that single food represents the food category.

Where there was more than one food item in a food category, the n represents the number of volunteers who rated any of those items in all 3 test periods.

no comparable items in the other ration group). Tables 5.2 and 5.3 show mean ratings for individual food items over the three test periods for T and B Rations, respectively.

Ratings of T and B Dinners

Mean ratings for each food category by ration group and test period are presented in Table 5.4. Dinner milk showed a significant main effect difference between ration groups, with the B Ration milk receiving significantly higher ratings ($p < 0.05$) than the T Ration milk (T Ration: 6.18 ± 1.90 vs. B Ration: 7.30 ± 1.25). Milk also showed significant ($p < 0.05$) differences in ratings over time with the lowest rating observed during T3 (Table 5.4). Significant ration group by test period interactions ($p < 0.05$) were observed for the entree, starch and vegetable categories, but the remaining dinner categories did not show significant interactions. Dinner entree ratings showed B Ration entrees maintained their acceptability ratings over time while T Rations acceptability decreased (Figure 5.2). B Ration starches were rated significantly higher ($p < 0.05$) than T Ration starches during T3 (Figure 5.3). B Ration vegetables were rated significantly higher ($p < 0.05$) than T ration vegetables during T2 and T3 (Figure 5.4). Tables 5.5 and 5.6 show mean ratings for individual food items over the three test periods for T and B Rations, respectively.

Ratings of Meals Ready-to-Eat (MREs)

Mean ratings for each MRE food category by ration group and test period are presented in Table 5.7. There was a significant ($p \leq 0.05$) main effect of ration group for the entrees, crackers, spreads, fruits, desserts, and candy categories. The volunteers in the B ration group rated these categories as being more acceptable than did those in the T Ration group. Significant differences ($p \leq 0.05$) were observed over time for the candy category; T2 and T3 ratings were lower than T1 ratings. No other significant differences between the three test periods were observed. Although the differences between the two groups tended to increase over the three test periods, these differences were not statistically significant ($p > 0.05$). There were no interaction effects. Tables 5.8 and 5.9 show mean ratings for individual food items over the three test periods for the T and B Ration groups, respectively.

Table 5.2. Acceptabilities of T Ration breakfast items over time.

Ration Item	T1		T2		T3	
	Mean ± S.D.	*n*	Mean ± S.D.	*n*	Mean ± S.D.	*n*
Eggs Scrambled Bacon and Cheese	4.74 ± 2.09	19	4.25 ± 2.90	12	4.82 ± 2.16	14
Eggs Omelet With Sausage	4.67 ± 2.25	18	4.67 ± 2.54	15	3.70 ± 2.83	15
Eggs Scrambled Western	Not Served		Not Served		4.46 ± 2.30	13
Pork Sausage Links	5.66 ± 1.61	21	4.95 ± 1.87	18	4.64 ± 2.19	17
Ham Slices	4.66 ± 2.03	19	3.29 ± 2.98	7	3.88 ± 2.36	8
Corn Beef Hash	4.78 ± 1.60	20	2.72 ± 1.73	9	3.00 ± 1.90	6
Potatoes With Bacon	Not Served		Not Served		5.00 ± 1.73	3
Oatmeal	7.36 ± 0.98	7	6.29 ± 2.42	8	6.48 ± 1.70	8
Fresh Fruit: Banana	7.44 ± 1.24	8	Not Served		Not Served	
Fresh Fruit: Apple	7.78 ± 0.97	9	Not Served		Not Served	
Canned Fruit: Fruit Cocktail	6.63 ± 1.67	16	Not Served		Not Served	
Canned Fruit: Pears	6.25 ± 2.05	8	6.14 ± 1.07	7	6.38 ± 2.20	8
Canned Fruit: Peaches	Not Served		Not Served		5.83 ± 2.41	12
Canned Fruit: Apple Dessert	6.19 ± 1.67	18	4.06 ± 2.01	9	4.64 ± 1.96	11
Spice Cake With Vanilla Crumbs	6.93 ± 1.29	20	5.08 ± 2.42	12	5.50 ± 2.48	11
Coffee Cake With Cinnamon Top	6.42 ± 1.77	18	5.54 ± 2.38	14	6.55 ± 1.75	11
Yellow Cake With Chocolate Crumbs	6.13 ± 1.73	8	6.25 ± 1.55	10	5.64 ± 2.06	11

Table 5.2 (Continued). Acceptabilities of T Ration breakfast items over time.

Chocolate Cake With Vanilla Crumbs	Not Served		Not Served		3.83 ± 2.04	6
Orange Juice	6.83 ± 1.54	21	3.80 ± 1.54	5	5.67 ± 2.29	6
Apple Juice	8.10 ± 1.02	5	6.88 ± 1.64	8	5.71 ± 2.55	8
Grape Juice	6.27 ± 2.16	11	6.00 ± 1.41	2	7.00 ± 0.00	1
Fruit Drink	5.00 ± 4.24	2	3.38 ± 2.43	4	4.05 ± 2.13	8
White Milk	6.53 ± 1.86	11	7.62 ± 1.29	6	5.33 ± 2.74	11
Chocolate Milk	6.25 ± 1.58	8	5.12 ± 2.62	9	6.08 ± 1.50	6
Coffee	7.25 ± 1.31	3	7.53 ± 1.28	4	7.44 ± 1.16	4
Pouch Bread	4.00 ± 1.63	4	Not Rated		Not Rated	
Jelly	7.38 ± 0.53	2	7.00 ± 0.00	1	6.25 ± 0.00	1
Peanut Butter	7.00 ± 0.00	1	Not Rated		Not Rated	

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like Nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.

Shaded items are those that are rated as less than 5.0 (Neither Like Nor Dislike); that is, they were items that were disliked to some degree

Table 5.3. Acceptabilities of B Ration breakfast items over time.

Ration Item	T1		T2		T3	
	Mean ± S.D.	*n*	Mean ± S.D.	*n*	Mean ± S.D.	*n*
Eggs Scrambled	6.24 ± 1.68	35	5.78 ± 2.13	33	5.66 ± 1.65	26
Bacon	5.81 ± 1.82	27	6.20 ± 1.38	25	6.37 ± 1.61	19
Creamed Ground Beef	6.42 ± 1.50	24	7.32 ± 1.46	22	7.06 ± 1.50	24
Roast Beef Hash	5.81 ± 1.91	32	5.55 ± 1.77	21	5.50 ± 1.83	13
SPAM Luncheon Meat	4.98 ± 1.90	33	5.23 ± 2.42	13	6.14 ± 1.68	7
Potatoes: Hash Browns	6.46 ± 1.50	34	5.83 ± 1.70	24	5.97 ± 1.67	27
Grits: Hominy	6.94 ± 1.29	16	6.37 ± 1.31	23	6.68 ± 1.43	22
Biscuits	6.61 ± 1.19	34	6.88 ± 1.20	36	6.84 ± 1.29	34
Fresh Fruit: Banana	7.70 ± 0.82	10	Not Served		Not Served	
Fresh Fruit: Apple	8.31 ± 0.95	16	Not Served		Not Served	
Fresh Fruit: Orange	6.25 ± 1.06	2	Not Served		Not Served	
Canned Fruit: Peaches	Not Served		Not Served		7.50 ± 1.17	12
Cinnamon Roll	7.00 ± 1.11	22	Not Served		Not Served	
Orange Juice	6.03 ± 2.11	36	6.91 ± 1.66	11	7.57 ± 1.51	7
Apple Juice	8.01 ± 0.66	16	7.80 ± 1.03	10	7.18 ± 1.18	12
Grape Juice	7.25 ± 1.17	6	6.75 ± 0.71	8	6.20 ± 0.84	5
Fruit Drink	6.17 ± 1.89	3	5.45 ± 2.40	17	6.59 ± 1.79	18

Table 5.3 (Continued). Acceptabilities of B Ration breakfast items over time.

White Milk	7.47 ± 1.22	12	7.43 ± 1.19	14	6.47 ± 1.72	17
Chocolate Milk	7.45 ± 1.25	16	7.57 ± 1.28	12	7.14 ± 1.69	13
Coffee	8.19 ± 0.83	6	7.78 ± 1.52	6	7.75 ± 1.11	8
Pouch Bread	5.02 ± 2.45	10	Not Rated		Not Rated	
Jelly	7.35 ± 1.08	14	7.38 ± 1.30	8	7.50 ± 1.00	7
Peanut Butter	7.12 ± 1.07	7	Not Rated		Not Rated	

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like Nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.
Shaded items are those that are rated as less than 5.0 (Neither Like Nor Dislike); that is, they were items that were disliked to some degree.

Table 5.4. Dinner food category acceptabilities over time.

Food Category by Ration Group	T1 Mean ± S.D.	n	T2 Mean ± S.D.	n	T3 Mean ± S.D.	n
Entree T Ration	6.29 ± 1.04	20	5.57 ± 1.79	20	4.72 ± 1.90	20
Entree B Ration	7.00 ± 1.12	38	6.46 ± 1.48	38	7.32 ± 1.04	38
Starch T Ration	6.31 ± 1.32	20	5.94 ± 1.94	20	5.08 ± 2.16	20
Starch B Ration	6.98 ± 1.09	37	6.68 ± 1.27	37	7.17 ± 1.01	37
Vegetables T Ration	6.38 ± 1.45	18	5.37 ± 1.95	18	5.11 ± 1.70	18
Vegetables B Ration	6.67 ± 1.31	37	6.57 ± 1.38	37	6.62 ± 1.30	37
Milk T Ration	6.54 ± 1.38	14	6.33 ± 2.17	14	5.68 ± 2.16	14
Milk B Ration	7.32 ± 1.16	21	7.33 ± 1.31	21	7.19 ± 1.28	21
Cake T Ration	5.96 ± 2.23	13	5.27 ± 1.78	13	5.09 ± 1.70	13
Cake B Ration	Not Served		Not Served		Not Served	
Dessert T Ration	Not Served		Not Served		Not Served	
Dessert B Ration	8.00 ± 0.91	18	7.67 ± 1.33	18	7.50 ± 1.27	18
Cookies T Ration	Not Served		Not Served		Not Served	
Cookies B Ration	7.21 ± 1.16	30	7.47 ± 1.28	30	7.43 ± 1.23	30

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like Nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.

* Ratings for the various food categories represent averages of the various foods that comprise that category. If the same food (e.g., white milk) was available to both groups, that single food represents the food category.

\# Where there was more than one food item in a food category, the n represents the number of volunteers who rated any of those items in all 3 test periods.

Figure 5.2. Dinner entree ratings: ration by test period interaction effect.

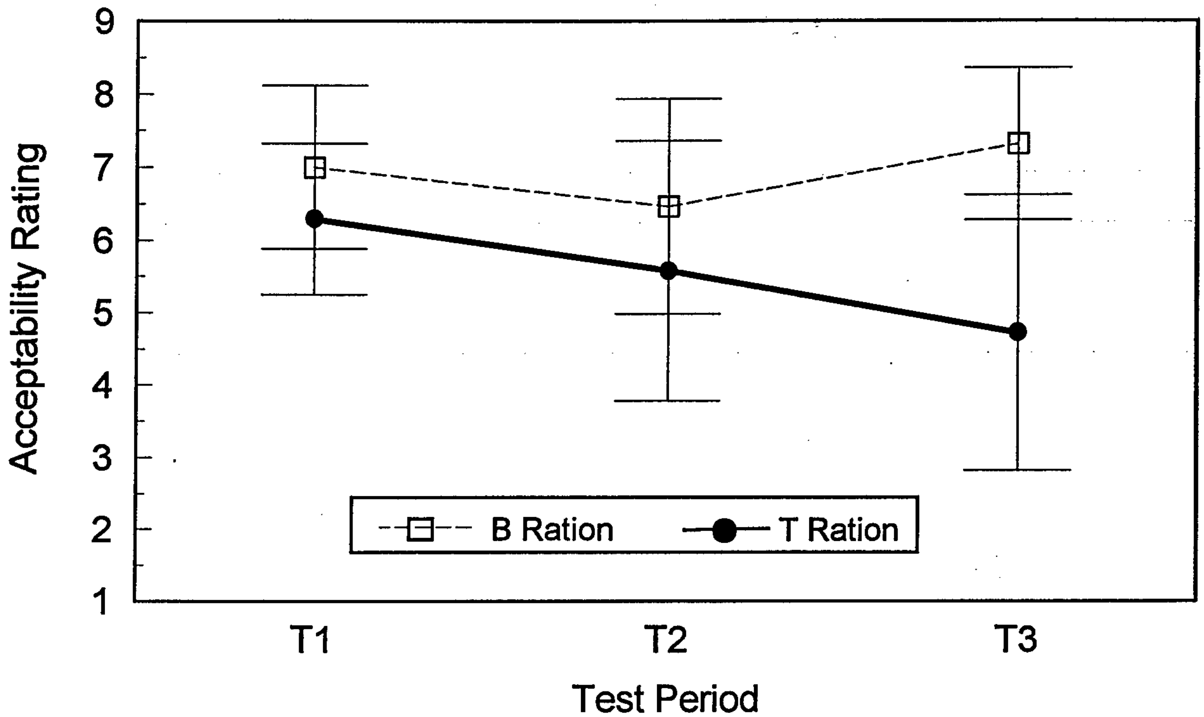

Figure 5.3. Dinner starch ratings: ration by test period interaction effect.

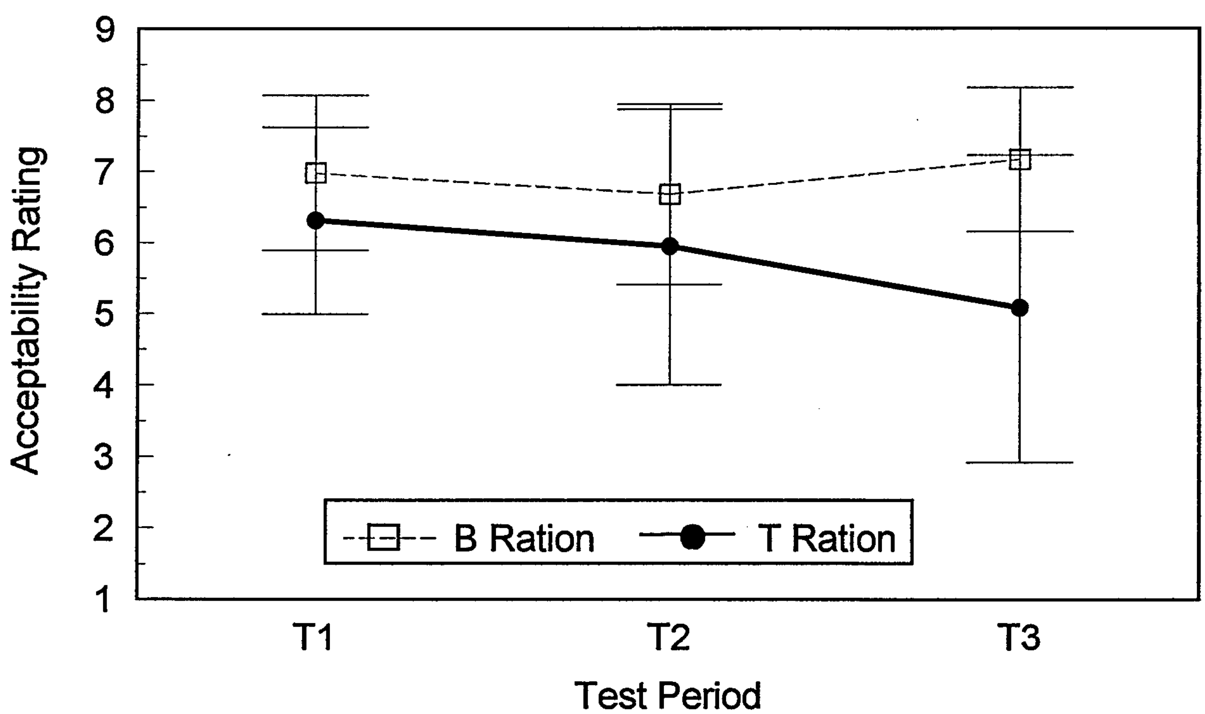

Figure 5.4. Dinner vegetable ratings: ration by test period interaction effect.

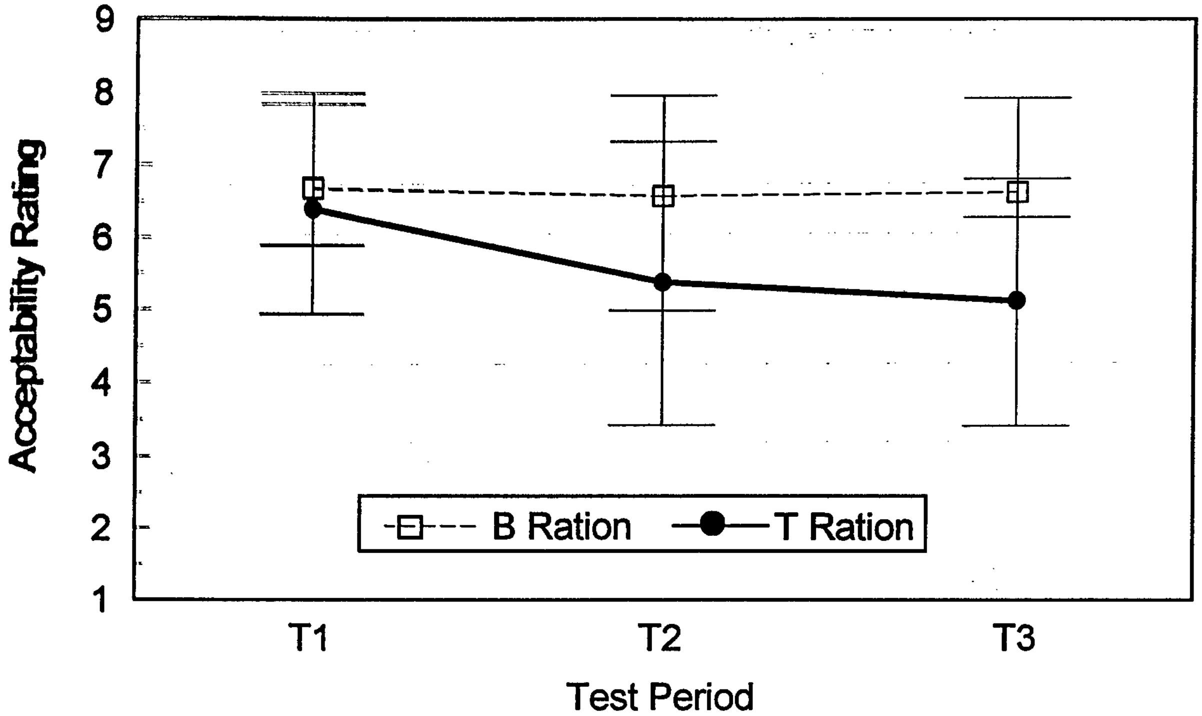

Table 5.5. Acceptabilities of T Ration dinner items over time.

Ration Item	T1		T2		T3	
	Mean ± S.D.	*n*	Mean ± S.D.	*n*	Mean ± S.D.	*n*
Spaghetti With Meatballs	6.75 ± 1.48	20	5.29 ± 2.26	17	Not Served	
Chicken Breast With Gravy	6.74 ± 1.63	20	Not Served		4.10 ± 2.27	20
Chicken Chow Mein	5.58 ± 2.17	19	Not Served		Not Served	
Beef Strips With Peppers	5.95 ± 2.15	19	Not Served		4.47 ± 2.39	15
Pork Ribs: BBQ Boneless	6.59 ± 1.37	17	Not Served		Not Served	
Meatballs With Gravy	6.00 ± 2.04	14	5.78 ± 2.18	18	6.06 ± 2.08	17
Turkey Slices With Gravy	Not Served		4.90 ± 1.45	10	Not Served	
Beef Stew	Not Served		5.53 ± 2.12	17	4.88 ± 2.12	17
Lasagna	Not Served		6.53 ± 1.97	17	Not Served	
Hamburger	Not Served		4.57 ± 2.51	7	4.75 ± 3.30	4
Potatoes in Butter Sauce	6.81 ± 1.33	16	6.10 ± 2.02	10	4.82 ± 2.47	19
Rice	5.68 ± 1.89	19	Not Served		5.25 ± 2.17	19
Red Beans With Rice	6.25 ± 1.65	16	Not Served		Not Served	
Peas	Not Served		4.86 ± 2.66	11	5.00 ± 2.26	12
Corn	6.93 ± 1.18	20	Not Served		5.72 ± 1.95	16
Green Beans	6.14 ± 1.84	18	Not Served		6.46 ± 1.71	13
Carrots	6.60 ± 1.99	15	Not Served		4.27 ± 2.10	11

Table 5.5 (Continued). Acceptabilities of T Ration dinner items over time.

Fresh Fruit: Apple	7.44 ± 1.40	8	Not Served		Not Served	
Applesauce	6.38 ± 1.69	8	Not Served		Not Served	
Canned Fruit: Fruit Cocktail	Not Served		6.56 ± 1.24	9	6.00 ± 2.45	
Chocolate Cake With Vanilla Crumbs	5.62 ± 1.83	17	5.44 ± 2.60	9	5.00 ± 2.09	11
Coffee Cake With Cinnamon	6.69 ± 2.14	13	5.29 ± 1.57	12	Not Served	
Spice Cake With Vanilla Crumbs	Not Served		5.69 ± 1.32	13	Not Served	
Yellow Cake With Chocolate Crumbs	Not Served		4.38 ± 2.53	13	5.58 ± 1.38	12
Devil's Fudge Cake With Coconut	5.53 ± 2.75	15	Not Served		Not Served	
Fruit Drink	4.30 ± 1.91	17	5.24 ± 2.25	10	4.84 ± 2.02	13
White Milk	6.78 ± 1.30	8	6.69 ± 2.56	8	5.23 ± 2.37	14
Chocolate Milk	6.04 ± 1.38	9	5.52 ± 2.49	13	5.47 ± 2.18	11
Apple Juice	Not Served		Not Served		4.00 ± 2.00	3
Orange Juice	Not Served		Not Served		6.00 ± 1.41	2
Pouch Bread	4.50 ± 1.80	3	Not Rated		Not Rated	
Jelly	Not Rated		6.00 ± 0.00	1	7.50 ± 1.00	7
Peanut Butter	7.50 ± 2.12	2	Not Rated		Not Rated	

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like Nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.

Shaded items are those that are rated as less than 5.0 (Neither Like Nor Dislike); that is, they were items that were disliked to some degree.

Table 5.6. Acceptabilities of B Ration dinner items over time.

Ration Item	T1		T2		T3	
	Mean ± S.D.	*n*	Mean ± S.D.	*n*	Mean ± S.D.	*n*
Chili Macaroni	7.47 ± 1.11	36	Not Served		Not Served	
Chili Con Carne	Not Served		6.50 ± 1.57	20	Not Served	
Creole Chicken	6.58 ± 1.87	33	5.83 ± 2.26	35	Not Served	
Beef and Gravy	6.47 ± 1.39	32	Not Served		Not Served	
Beef With Gravy and Vegetables	7.25 ± 1.70	32	Not Served		7.46 ± 1.24	35
Beef Stew	Not Served		7.09 ± 1.44	35	Not Served	
Beef Patties	Not Served		Not Served		7.32 ± 1.32	34
Shrimp Creole	6.93 ± 1.62	30	6.33 ± 1.99	33	6.04 ± 2.09	28
Chicken With Rice	7.27 ± 1.31	30	7.51 ± 1.07	35	7.76 ± 1.09	33
Baked Ham and Macaroni	Not Served		5.82 ± 2.38	34	Not Served	
Pork Chops	Not Served		Not Served		7.66 ± 1.24	35
Potatoes: Mashed	7.18 ± 1.23	36	6.94 ± 1.30	34	7.47 ± 1.11	36
Rice	6.81 ± 1.31	36	6.30 ± 1.52	37	6.82 ± 1.21	34
Green Beans	6.01 ± 2.02	34	5.78 ± 2.02	23	5.53 ± 1.87	29
Corn	7.48 ± 1.12	33	7.51 ± 1.13	35	7.84 ± 1.17	32
Carrots	6.36 ± 1.87	25	6.12 ± 1.83	25	Not Served	
Peas	6.96 ± 1.55	23	6.91 ± 1.31	23	6.52 ± 1.65	31

Table 5.6 (Continued). Acceptabilities of B Ration dinner items over time.

Peas and Carrots	Not Served		6.13 ± 2.07	24	6.00 ± 2.09	22
Fresh Fruit: Apple	7.91 ± 0.77	18	Not Served		Not Served	
Canned Fruit: Peaches	7.65 ± 1.60	26	Not Served		7.59 ± 1.26	27
Canned Fruit: Fruit Cocktail	7.69 ± 0.95	16	Not Served		Not Served	
Canned Fruit: Apple Dessert	6.19 ± 1.67	18	Not Served		7.73 ± 1.08	30
Cherry Cobbler Crisp	7.68 ± 1.49	25	7.71 ± 1.37	24	7.62 ± 1.24	21
Peach Crunch	Not Served		Not Served		7.75 ± 1.39	8
Chocolate Brownie W/ Chocolate Top	7.59 ± 1.31	27	Not Served		Not Served	
Chocolate Brownie W/ No Icing	Not Served		7.37 ± 1.59	30	Not Served	
Yellow Cake	Not Served		7.13 ± 1.63	16	Not Served	
Cookies: Oatmeal	7.17 ± 1.07	18	7.74 ± 1.18	23	7.30 ± 1.34	30
Cookies: Sugar	6.23 ± 1.09	13	Not Served		Not Served	
Cookies: Peanut Butter	Not Served		7.61 ± 1.37	33	7.30 ± 1.39	30
Biscuits	6.98 ± 1.94	29	Not Served		Not Served	
Corn Bread	6.42 ± 2.06	26	Not Served		Not Served	
Sweet Corn Bread	7.58 ± 1.56	19	Not Served		Not Served	
Fruit Drink	5.73 ± 2.12	26	6.90 ± 1.54	23	6.65 ± 1.80	28
Apple Juice	Not Served		Not Served		7.40 ± 0.55	5

Table 5.6 (Continued). Acceptabilities of B Ration dinner items over time.

Orange Juice	Not Served		Not Served		7.50 ± 1.29	4
White Milk	7.32 ± 1.13	17	7.21 ± 1.36	15	6.72 ± 1.68	20
Chocolate Milk	7.57 ± 1.24	17	7.52 ± 1.31	14	7.62 ± 1.09	12
Pouch Bread	6.09 ± 1.24	8	Not Rated		Not Rated	
Jelly	8.08 ± 1.03	3	7.63 ± 0.95	4	7.00 ± 0.00	1
Peanut Butter	8.00 ± 1.41	2	Not Rated		Not Rated	

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like Nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.

Shaded items are those that are rated as less than 5.0 (Neither Like Nor Dislike); that is, they were items that were disliked to some degree.

Table 5.7. Acceptabilities of Meal Ready-to-Eat (MRE) food categories over time.

Food Category by Ration Group		T1 Mean ± S.D.	T1 *n*	T2 Mean ± S.D.	T2 *n*	T3 Mean ± S.D.	T3 *n*
Entrees:	T Ration	6.9 ± 0.9	21	6.4 ± 1.2	19	6.5 ± 1.2	18
	B Ration	7.0 ± 1.1	36	7.0 ± 1.1	32	7.2 ± 1.1	36
Starches:	T Ration	6.7 ± 1.7	13	7.0 ± 0.8	7	6.4 ± 1.2	7
	B Ration	6.8 ± 1.4	15	7.0 ± 1.3	15	7.8 ± 0.7	15
Crackers:	T Ration	6.4 ± 1.4	19	6.4 ± 1.3	17	5.8 ± 1.7	16
	B Ration	6.8 ± 1.4	35	7.1 ± 1.2	27	7.0 ± 1.3	32
Spreads:	T Ration	6.9 ± 1.1	21	6.4 ± 1.2	17	6.3 ± 1.5	16
	B Ration	7.3 ± 1.0	32	7.3 ± 1.0	29	7.4 ± 1.0	33
Snacks:	T Ration	7.5 ± 1.3	10	6.9 ± 1.2	6	7.2 ± 1.2	9
	B Ration	7.6 ± 1.7	20	7.9 ± 1.3	20	7.8 ± 1.2	12
Fruits:	T Ration	7.5 ± 1.3	17	6.8 ± 1.4	16	6.4 ± 1.1	14
	B Ration	7.8 ± 1.1	30	7.7 ± 1.3	27	7.9 ± 1.0	27
Desserts:	T Ration	6.8 ± 1.4	17	6.1 ± 1.5	16	5.8 ± 1.9	15
	B Ration	7.2 ± 1.0	34	7.2 ± 1.2	26	7.0 ± 1.2	32
Candies:	T Ration	7.6 ± 1.1	18	6.2 ± 2.0	12	7.0 ± 1.3	14
	B Ration	8.3 ± 0.7	31	7.6 ± 1.1	28	7.6 ± 1.2	32
Drinks:	T Ration	7.0 ± 1.2	12	7.5 ± 1.2	10	7.2 ± 1.4	10
	B Ration	7.4 ± 1.0	27	7.6 ± 1.1	20	7.3 ± 1.2	23
Other:	T Ration	7.2 ± 1.4	17	7.0 ± 1.2	15	6.5 ± 1.4	13
	B Ration	7.3 ± 1.4	31	7.3 ± 1.2	26	7.4 ± 1.1	26

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.

Table 5.8. Acceptability of Meal Ready-to-Eat (MRE) items over time for the T Ration group.

Ration Item	T1		T2		T3	
	Mean ± S.D.	*n*	Mean ± S.D.	*n*	Mean ± S.D.	*n*
Tuna With Noodles	8.0 ± 0.0	1	5.0 ± 1.7	3	NA	0
Chicken Stew	7.0 ± 1.4	2	6.0 ± 1.0	3	5.4 ± 2.7	5
Ham Slice	6.8 ± 1.7	4	6.7 ± 1.4	6	7.5 ± 0.6	4
Spaghetti With Meat Sauce	6.7 ± 0.6	3	6.2 ± 0.8	5	6.1 ± 1.1	6
Beef Franks	6.0 ± 0.8	4	5.1 ± 1.8	4	5.3 ± 2.3	6
Beef Stew	6.1 ± 2.4	7	7.0 ± 0.0	2	5.6 ± 2.9	5
Beef Steak	7.3 ± 1.0	6	7.7 ± 1.2	3	6.5 ± 5.5	5
Chicken With Rice	6.8 ± 0.8	6	6.5 ± 1.2	7	6.6 ± 1.1	5
Pork Chow Mein	7.3 ± 0.6	3	5.0 ± 2.6	3	4.0 ± 1.4	2
Chili With Macaroni	7.8 ± 0.4	5	6.5 ± 1.4	6	7.0 ± 1.7	6
Pasta With Vegetables	7.7 ± 0.6	3	6.7 ± 1.5	6	6.2 ± 1.2	6
Cheese Tortellini	6.5 ± 2.1	6	6.8 ± 1.3	5	5.7 ± 3.2	3
Pork With Rice	7.8 ± 1.5	4	6.5 ± 2.1	2	7.0 ± 0.0	1
Grilled Chicken	7.1 ± 1.1	9	7.7 ± 1.2	3	6.8 ± 1.0	4
Scalloped Potatoes With Ham	5.5 ± 2.0	6	5.5 ± 3.5	2	5.3 ± 1.1	2
Mexican Rice	7.1 ± 0.8	7	7.0 ± 1.0	3	6.6 ± 0.5	4
White Rice	6.0 ± 2.3	6	7.0 ± 1.0	3	6.8 ± 1.6	4
Crackers	6.4 ± 1.4	19	6.4 ± 1.3	17	5.8 ± 1.7	16
Chow Mein Noodles	7.7 ± 0.6	3	6.5 ± 0.7	2	5.0 ± 0.0	1
Peanut Butter	6.7 ± 1.1	15	6.1 ± 1.5	9	5.5 ± 2.3	9
Jelly	6.1 ± 1.4	4	6.4 ± 1.3	7	6.2 ± 0.9	4
Cheese Spread	6.7 ± 1.6	12	6.9 ± 1.2	10	6.6 ± 1.3	12
Jalapeno Cheese	7.9 ± 0.8	6	7.0 ± 1.0	3	8.0 ± 0.0	3
Potato Sticks	7.6 ± 0.5	5	7.8 ± 0.3	3	7.3 ± 1.0	8

Table 5.8 (Continued). Acceptability of Meal Ready-to-Eat (MRE) items over time for the T Ration group.

Granola Bar	7.4 ± 2.2	8	6.0 ± 1.0	3	5.5 ± 2.1	2
Peaches	7.6 ± 1.7	5	6.8 ± 1.3	4	7.0 ± 1.6	5
Pears	8.6 ± 0.9	5	7.1 ± 1.5	5	6.5 ± 2.2	3
Mixed Fruit	7.2 ± 1.3	5	6.4 ± 1.5	5	6.0 ± 0.8	4
Pineapples	8.4 ± 0.9	5	8.0 ± 1.0	3	6.7 ± 1.1	7
Applesauce	6.9 ± 1.3	9	6.9 ± 1.6	10	6.2 ± 1.2	7
Fudge Brownie	5.4 ± 3.0	4	5.8 ± 3.3	5	4.3 ± 3.1	3
Oatmeal Cookie Bar	6.2 ± 2.2	5	6.1 ± 1.3	9	5.8 ± 1.6	5
Chocolate Covered Cookie	6.8 ± 2.0	8	7.5 ± 0.0	1	4.3 ± 1.7	4
Chocolate Mint Pound Cake	7.0 ± 0.0	1	3.5 ± 3.5	2	NA	0
Vanilla Pound Cake	7.4 ± 1.3	7	6.3 ± 1.7	4	6.0 ± 1.0	3
Orange Pound Cake	7.2 ± 1.6	5	5.0 ± 0.0	1	6.0 ± 0.0	1
Lemon Pound Cake	7.8 ± 1.3	4	6.0 ± 1.0	3	6.7 ± 1.5	3
Pineapple Pound Cake	7.3 ± 1.2	3	8.3 ± 1.2	3	6.9 ± 1.7	4
Charms	7.0 ± 1.5	7	5.8 ± 3.0	4	6.5 ± 2.1	2
Tootsie Roll	7.8 ± 1.3	4	6.4 ± 1.4	5	7.4 ± 1.3	6
M&Ms	7.8 ± 1.0	12	7.1 ± 1.4	5	7.0 ± 1.2	9
Caramels	8.0 ± 1.2	4	5.0 ± 0.0	1	6.3 ± 1.5	3
Beverage Base With Sugar	7.0 ± 1.2	11	7.7 ± 1.2	10	7.0 ± 1.5	8
Lemon Tea With Sugar	7.5 ± 0.6	4	7.3 ± 1.5	3	7.6 ± 1.3	5
Cocoa	6.5 ± 0.7	2	NA	0	NA	0

Table 5.8 (Continued). Acceptability of Meal Ready-to-Eat (MRE) items over time for the T Ration group.

Salt	6.9 ± 1.7	4	5.4 ± 1.4	3	6.0 ± 0.0	1
Sugar	7.8 ± 1.9	4	7.1 ± 1.5	4	6.9 ± 1.2	2
Creamer	9.0 ± 0.0	1	NA	0	5.0 ± 0.0	1
Hot Sauce	7.2 ± 1.4	8	7.1 ± 1.4	7	6.1 ± 1.7	8
Gum	7.4 ± 1.2	12	7.0 ± 1.2	14	6.9 ± 1.3	11

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.
Shaded items are those that are rated as less than 5.0 (Neither Like Nor Dislike); that is, they were items that were disliked to some degree.

Table 5.9. Acceptability of Meal Ready-to-Eat (MRE) items over time for the B Ration group.

Ration Item	T1 Mean ± S.D.	n	T2 Mean ± S.D.	n	T3 Mean ± S.D.	n
Tuna With Noodles	6.7 ± 0.8	7	7.3 ± 0.6	3	6.6 ± 1.5	5
Chicken Stew	7.3 ± 1.1	9	7.4 ± 1.7	7	6.5 ± 1.1	8
Ham Slice	6.0 ± 0.8	4	7.5 ± 0.5	3	7.0 ± 1.4	6
Spaghetti With Meat Sauce	7.2 ± 1.1	13	7.4 ± 1.9	5	6.4 ± 1.9	7
Beef Franks	5.4 ± 2.0	10	5.8 ± 1.9	12	5.8 ± 2.2	4
Beef Stew	6.5 ± 2.5	11	7.4 ± 1.8	9	7.5 ± 1.0	12
Beef Steak	6.1 ± 0.5	5	5.4 ± 2.2	8	6.7 ± 0.6	3
Chicken With Rice	7.5 ± 1.2	11	6.5 ± 2.2	11	7.0 ± 1.3	11
Pork Chow Mein	6.3 ± 2.3	12	6.2 ± 1.9	5	7.4 ± 0.7	8
Chili With Macaroni	7.9 ± 1.0	13	8.0 ± 0.8	9	7.9 ± 1.1	14
Pasta With Vegetables	7.8 ± 1.3	15	8.2 ± 0.9	10	7.0 ± 1.5	8
Cheese Tortellini	7.0 ± 1.5	9	7.2 ± 1.6	9	7.5 ± 0.5	6
Pork With Rice	7.1 ± 0.9	5	7.5 ± 0.7	2	7.2 ± 1.0	7
Grilled Chicken	6.2 ± 1.2	9	6.7 ± 1.7	9	7.2 ± 1.4	7
Scalloped Potatoes With Ham	7.2 ± 1.5	6	6.6 ± 1.8	4	8.3 ± 0.4	5
Mexican Rice	6.6 ± 1.6	7	7.0 ± 1.2	7	7.6 ± 0.5	7
White Rice	6.1 ± 2.5	4	7.1 ± 1.5	8	8.1 ± 0.6	7
Crackers	6.8 ± 1.4	35	7.1 ± 1.2	27	7.0 ± 1.3	32
Chow Mein Noodles	7.2 ± 1.5	8	7.0 ± 0.0	3	7.7 ± 0.8	6
Peanut Butter	7.0 ± 1.2	23	6.9 ± 1.7	20	7.0 ± 1.2	24
Jelly	6.8 ± 1.4	13	6.9 ± 1.5	9	6.8 ± 1.7	13
Cheese Spread	8.0 ± 1.2	13	7.4 ± 1.2	14	8.0 ± 0.8	18
Jalapeno Cheese	8.0 ± 1.1	18	7.9 ± 1.1	17	8.0 ± 1.2	20
Potato Sticks	7.0 ± 1.9	13	7.5 ± 1.9	11	7.4 ± 1.4	3

Table 5.9 (Continued). Acceptability of Meal Ready-to-Eat (MRE) items over time for the B Ration group.

Granola Bar	8.3 ± 1.0	10	7.8 ± 1.3	12	7.9 ± 1.2	9
Peaches	7.9 ± 0.8	14	7.7 ± 1.8	10	8.4 ± 0.6	12
Pears	7.9 ± 1.0	9	7.8 ± 1.3	12	7.9 ± 1.1	8
Mixed Fruit	7.9 ± 1.2	12	8.1 ± 0.8	10	8.6 ± 0.5	10
Pineapples	8.1 ± 1.1	10	7.8 ± 1.0	12	7.6 ± 1.3	5
Applesauce	7.4 ± 1.4	19	7.6 ± 1.2	14	7.7 ± 1.0	15
Fudge Brownie	7.1 ± 1.4	17	7.0 ± 1.2	13	6.5 ± 1.8	18
Oatmeal Cookie Bar	6.6 ± 1.8	12	6.8 ± 1.6	13	6.5 ± 1.6	10
Chocolate Covered Cookie	7.3 ± 1.4	17	7.2 ± 1.0	10	7.2 ± 1.4	18
Chocolate Mint Pound Cake	7.6 ± 1.1	5	6.5 ± 0.7	2	7.1 ± 1.4	6
Vanilla Pound Cake	7.4 ± 1.1	7	7.5 ± 0.7	2	7.3 ± 1.1	2
Orange Pound Cake	7.2 ± 0.8	5	8.0 ± 0.0	1	8.0 ± 0.8	8
Lemon Pound Cake	7.4 ± 0.9	7	7.8 ± 1.5	6	7.4 ± 1.3	8
Pineapple Pound Cake	8.0 ± 1.0	5	6.3 ± 1.2	3	7.5 ± 1.7	4
Charms	7.8 ± 1.0	12	6.8 ± 0.6	8	6.7 ± 1.3	13
Tootsie Roll	8.4 ± 0.5	7	7.8 ± 1.3	8	8.3 ± 0.9	12
M&Ms	8.4 ± 0.6	24	7.9 ± 1.1	20	7.9 ± 1.1	23
Caramels	7.0 ± 1.6	4	6.6 ± 1.0	7	6.8 ± 1.1	5
Beverage Base With Sugar	7.3 ± 1.1	22	7.4 ± 1.1	18	7.3 ± 1.2	21
Lemon Tea With Sugar	8.1 ± 0.9	7	8.3 ± 1.1	7	7.3 ± 1.7	7
Coffee	NA	0	7.0 ± 0.0	1	7.0 ± 0.0	1
Cocoa	7.5 ± 1.3	3	7.0 ± 1.4	2	7.0 ± 0.0	1

Table 5.9 (Continued). Acceptability of Meal Ready-to-Eat (MRE) items over time for the B Ration group.

Salt	6.5 ± 1.8	8	7.3 ± 2.1	3	7.3 ± 2.1	3
Sugar	7.0 ± 2.4	6	9.0 ± 0.0	1	7.5 ± 1.6	5
Creamer	9.0 ± 0.0	1	5.5 ± 0.7	2	7.2 ± 0.9	4
Hot Sauce	8.0 ± 1.5	13	7.4 ± 0.9	10	7.5 ± 1.2	10
Gum	7.5 ± 1.3	26	7.3 ± 1.4	24	7.4 ± 1.2	22

Key: The following served as the anchor ratings for the corresponding scores: 1 = Dislike Extremely, 2 = Dislike Very Much, 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.
Shaded items are those that are rated as less than 5.0 (Neither Like Nor Dislike); that is, they were items that were disliked to some degree.

DISCUSSION

As Rolls (12) has stated, the amount of food consumed is mediated by a number of factors. Physiological changes in the blood, such as the presence of various nutrients, or a physical fullness of the stomach influence a person's appetite. Environmental factors such as hot weather stimulate the desirability or avoidance of certain foods (3). Even hungry individuals have been reported to restrict food intake if the food presented has previously caused them to be sick or if the food is distasteful. Contrary to this, as can be seen at summer picnics or Thanksgiving dinners, a variety of tasteful foods eaten in a festive atmosphere often leads to consumption beyond the point of satiety (7). Within a certain meal, if a variety of foods are offered, more food will be consumed (12). Likewise, repetition of the same foods over meals is likely to decrease acceptance of that food and associated consumption as was observed on this study. Rolls (12) has concluded that both variety and palatability are important influences on feeding. Whereas most research has focused on factors which lead to obesity and how those factors can be manipulated to reduce consumption, field-feeding of military troops (for whom underconsumption is notorious) (10), may attempt to maximize those factors that will increase consumption.

Previous research (14,15) has shown that the acceptability of the main components of the meal (entree, meat, and vegetable categories) will decrease as a result of repeated exposure, and that highly rated items show minimal or no decreases in acceptability over time. During the current study, the T Ration entrees showed a significant decrease, and the B Ration dinner entrees showed a significant increase in acceptability across test periods. The decrease in T Ration acceptability may have resulted from the volunteers becoming bored with the more monotonous T Ration menu cycle, particularly since intitial ratings for many of the items were not high (i.e., < 7.0). The perception of monotony for the T Ration group may have been exacerbated because volunteers in the different groups were not isolated and therefore could observe but not select the more desirable and familiar B Ration foods at each meal. Since they could not have these foods, frustration regarding their ration choices was probably increased. Acceptability ratings of foods in both B and T Rations were lower in general than those observed during a 12-day study with the UGR menu (6). The three most likely explanations for these differences are that 1) this study lasted much longer with food servings repeating more often, 2) in the UGR study, volunteers ate foods from both B and T Ration menus, further increasing variety, and 3) fresh fruits and salad supplemented the UGR, while during this study, fresh fruit and salad supplementations were very limited.

An examination of T and B Ration breakfast food acceptabilities (Tables 5.2 and 5.3) show that T Ration breakfasts were especially problematic with acceptabilities decreasing over time for most items. Across all time periods, all breakfast entrees were deemed unacceptable, whereas for the B Ration group, only Spam was seen as unacceptable during T1. Spam increased in its acceptability possibly because those who did not like it initially chose other items instead. For those in the T Ration group there were no acceptable breakfast choices. While the cakes were viewed as acceptable, they are not a substitute for unacceptable breakfast foods. In previous findings on hunger, Kramer et al. (8) report that hunger 2 hours after a meal was less when eating meal-appropriate foods (e.g., typical breakfast foods at breakfast time) than when eating meal inappropriate foods (e.g., typical lunch or dinner foods at breakfast time). If Marines are eating an abundance of cakes at breakfast because they are preferred over the entree, feelings of hunger are likely to develop along with feelings that their ration was deficient in meeting their needs.

The breakfast fruit drink/juice, breakfast and dinner milk, and MRE food items were common to both rations. When fruit drink/juice and MRE foods were rated with the more acceptable B Rations, they received higher ratings than the fruit drink/juice and MRE foods consumed by the T Ration group. Since the two groups received the same beverages at the same time and the same location, other differences (e.g., the temperature of the beverage) would not be an issue. These foods show that acceptability of all food items is influenced by their accompanying items. Therefore, if the entrees or main food components of the ration are perceived to be inferior, they are likely to drive down the acceptability of all food items.

CONCLUSIONS

- All T Ration breakfast entrees were deemed unacceptable with consistent ratings of dislike (i.e., a mean rating < 5.0). In comparison, only the Spam item was rated as being disliked among all B Ration breakfast items. Because there were many choices during T2 and T3, its rating increased because those that liked it continued to eat it, while those that did not like it had other acceptable choices to choose from.

- T Ration dinner items initially were viewed as acceptable (T1 ratings were above 5.0). However, repeated exposure to these items produced ratings of dislike (i.e., a mean rating < 5.0) during T2 and T3 in the majority of the entrees. B Ration dinner items had no foods rated as disliked. The T Ration dinner menu showed that repeated servings of limited items decrease the acceptability of foods that initially were acceptable.

- The mean ratings of foods common to both ration groups were influenced by the overall acceptability of that ration (i.e., T or B Ration). Common foods were rated lower when eaten with the T Ration.

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CHAPTER 6

ENERGY EXPENDITURE, WATER TURNOVER, AND HYDRATION STATUS

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INTRODUCTION

Energy Expenditure

Field rations must meet the energy requirements of military personnel performing their jobs in combat or during field training exercises. Examination of energy requirements under various conditions has been aided greatly by the use of the doubly labeled water (DLW) method of assessing total daily energy expenditure (TDEE). This technique can measure TDEE over several days, and does not interfere with an individual's job performance or alter his/her daily routine, providing an accurate measure of TDEEs of free-living individuals.

There have been numerous studies of military personnel operating under terrestrial and environmental extremes that have used the DLW method to assess TDEE (4,9,11,12,13,17,27). Under these training scenarios TDEEs exceeding 5000 kcal/day have been observed and often lead to large negative energy balances. More recent studies have assessed TDEE of deployed personnel by the DLW method under more temperate and less physically demanding conditions. A study of Marine artillery personnel performing a firing mission in moderate temperatures found TDEE to average 4100 kcal/day (25), while energy expenditures of an Army transportation company averaged 3550 kcal/day (26). Combat support hospital personnel expended about 4000 kcal/day and 2750 kcal/day for men and women, respectively (2). However, to date there have been no studies that have examined the ability of tray pack rations (T Rations) to meet the energy requirements of military personnel in the field, nor have the energy requirements of military construction engineers, the volunteers in this study, been documented.

The T Ration provides on average, 1420 kcal/meal, while the Meal, Ready-to-Eat (MRE) provides 1300 kcal/meal. Standard procedure is to feed two T Ration meals plus an MRE a day totalling 4140 kcal/day, exceeding the Nutritional Standard for Operational Rations (NSOR) of 3600 kcals/day (5). This NSOR of 3600 kcal/day is designed to provide the energy needs of most personnel in a wide variety of extended field operations. However, this standard may not adequately provide for the needs of select units that engage in heavy physical activity. The high levels of TDEE previously mentioned have been attributed to the extended length of the work day, and the intense physical demands of load carriage and other combat tasks (11,12,13).

Hydration State

Data from a previous study which examined long-term (36 days) consumption of T Rations indicated that body hydration levels were maintained throughout the 36 days (30). Subsequent studies (16,20) on a redesigned T Ration also demonstrated that hydration status was not significantly affected by consumption of the T Ration. Urine specific gravities (USGs) were used to assess hydration status in the above studies. The most direct indicator of body hydration status is a change in total body water (TBW) measured by stable isotopes (19). In this study we used the stable isotope method to determine if there were changes in hydration status over each test period (T1, T2, and T3), and USGs to examine day-to-day changes in hydration state.

METHODS

Volunteers

A sub-sample of 16 volunteers from the main group of volunteers (5 consuming the T Ration, 10 consuming the B Ration, and 1 consuming both rations) completed the TDEE protocol. Of these volunteers, 10 construction engineers had purportedly more physical job requirements, while the other 6 volunteers (4 platoon or squad leaders, a clerk, and a surveyor) were thought to have more moderate physical job requirements. These volunteers were dosed with DLW as described below. An additional two volunteers, one in each ration group, were dosed with local bottled drinking water to monitor background isotopic changes. All 18 volunteers provided urine samples for estimation of hydration status by USGs.

Energy Expenditure and Water Turnover

All volunteers were instructed to consume nothing orally for the 6 hours prior to testing. On the morning (See Table 1.1) of each dosing with DLW for T1 (Days 1-10), T2 (Days 33-39), and T3 (Days 54-60) test periods of the study, volunteers provided a baseline urine sample. Volunteers then drank 0.22 g/kg estimated total body water (0.6 X body weight) of $H_2^{18}O$ (Isotec, Miamisburg, OH) and 0.16 g/kg estimated total body water of ^2H_2O (Cambridge Isotopes, Cambridge, MA) mixed with 50 ml of bottled water. The DLW dose container was rinsed with an additional 50 ml bottled water which the volunteer drank.

First-morning-void urine samples were collected on each of the six days (nine days for T1) following each dosing. Urine samples were collected and stored in 50 ml conical tubes (Becton Dickinson, Franklin Lakes, NJ). Samples were shipped on Blue Ice® and then frozen at Pennington Biomedical Research Center (PBRC) in Baton Rouge, LA, until they were isotopically analyzed.

Total body water, water turnover and energy expenditure measures were assessed using the methods previously described (4,12) except that TBW was estimated from urine samples using a linear regression equation. As has been previously cited (13), isotopic elimination rates for ^2H and ^{18}O were corrected for changes in baseline isotopic abundances (22). Isotope analyses were performed at the Stable Isotope Laboratory, PBRC, using an isotope ratio mass spectrometer as previously described (4).

Body Weight

Nude body weights were assessed at T1 prior to dosing with the DLW. After volunteers were deployed to the field test site, nude body weights were assessed one time per week. These weights were assessed at night to coincide with shower hours so that nude body weights could be obtained. Body weight was assessed using a calibrated electronic battery-powered scale accurate to 0.1 kg (Seca, Birmingham, England).

Hydration Status Estimated From Urine Specific Gravities (USGs)

Urine specific gravities (USGs) were assessed daily on the volunteer's first morning void. During T1, USGs were assessed on only the first 7 of the 9 days. The USGs are used as a rough index of hydration status. Specific gravity of urine is a measure of the solute present in a specific volume of urine. When hypohydration occurs, USG increases. Normal USG is between 1.010 -1.022. Values above 1.030 generally indicate hypohydration (10). To measure USG, a drop of urine was placed on a refractometer's platform, and the USG was read from the calibrated scale.

Statistical Analyses

Descriptive statistics were calculated to establish measures of central tendency (means), and amount of dispersion (standard deviations) by ration group and over time. A repeated measures analysis of variance (ANOVA) over test periods (T1, T2, and T3) with a grouping factor (T vs. B Ration) was conducted on each dependent variable: TDEE, TBW, and water turnover. For USG, the ANOVA consisted of test day (1-7) nested within test phase with ration type as the grouping factor. Significant ANOVAs of

$p < 0.10$ are reported. Post hoc differences were evaluated using Dunnett's (changes from baseline) or Tukey's (day to day or test period changes) multiple comparison post hoc tests, based on $p \leq 0.05$ level of statistical significance.

RESULTS

Energy Expenditure

The average TDEE for all volunteers over the three test periods was 3328 ± 637 kcal/day. There were no significant differences between ration groups (T Ration: 3432 ± 849 kcal/day vs. B Ration: 3246 ± 584 kcal/day). Table 6.1 shows TDEE by ration group for each of the three test periods. Figure 6.1 shows TDEE for all volunteers over time. Construction engineers tended to expend more energy than the administrative and support personnel ($p \leq 0.08$; construction engineers: 3460 ± 732 kcal/day vs. administrative and support personnel: 3109 ± 543 kcal/day). Figure 6.2 shows TDEE by job type for the three test periods. There were no significant differences between test periods, nor were there any significant interaction effects.

Energy Balance

There was a mean negative energy balance in both ration groups over all three test periods, with an average of -560 ± 960 kcal/day (energy intake: 2749 ± 595 kcal/day and TDEE: 3309 ± 666 kcal/day) for all volunteers. While not statistically significant, the smallest negative energy balance was during T2. Changes in energy balance over time are illustrated in Figure 6.3. Those consuming the T Ration showed a non-significant tendency toward a larger negative energy balance compared to those in the B Ration group (T Ration: -784 ± 1096 kcal/day vs. B Ration: -448 ± 887 kcal/day). Table 6.1 summarizes average daily energy balances, energy expenditures, and energy intakes for the two ration groups for the three test periods. When examined by percentages of individuals during T1 and T3, 100% in both ration groups were in a negative energy balance. During T2, 4 of 5 (80%) T Ration volunteers and 8 of 10 (80%) B Ration volunteers were in negative energy balances.

Table 6.1. Energy balance (energy intake - energy expenditure [TDEE]) by ration group over time.

	T1		T2		T3	
	T Ration (*n*=5)	B Ration (*n*=10)	T Ration (*n*=5)	B Ration (*n*=10)	T Ration (*n*=5)	B Ration (*n*=10)
Energy Intake	2812 ± 584	2903 ± 429	2725 ± 519	2889 ± 677	2409 ± 562	2604 ± 819
Energy Expenditure	3414 ± 741	3559 ± 525	3154 ± 859	3106 ± 583	3730 ± 947	3074 ± 646
Energy Balance	-602 ± 824	-656 ± 721	-429 ± 1163	-217 ± 1015	-1321 ± 1303	-470 ± 925

Figure 6.1. Total daily energy expenditure (TDEE) over time for all volunteers (n=16).

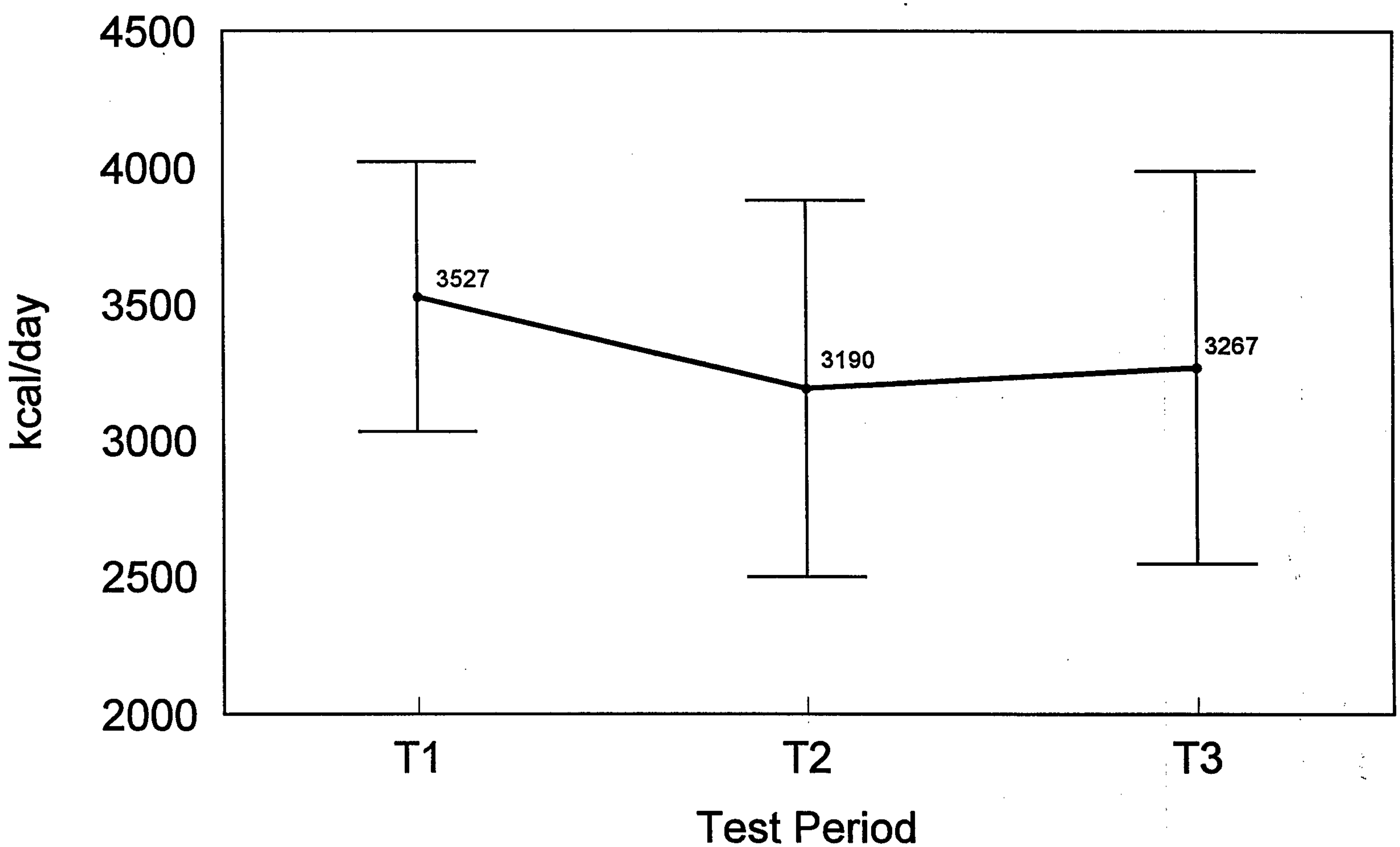


Figure 6.2. Total daily energy expenditure (TDEE) by job type over time.

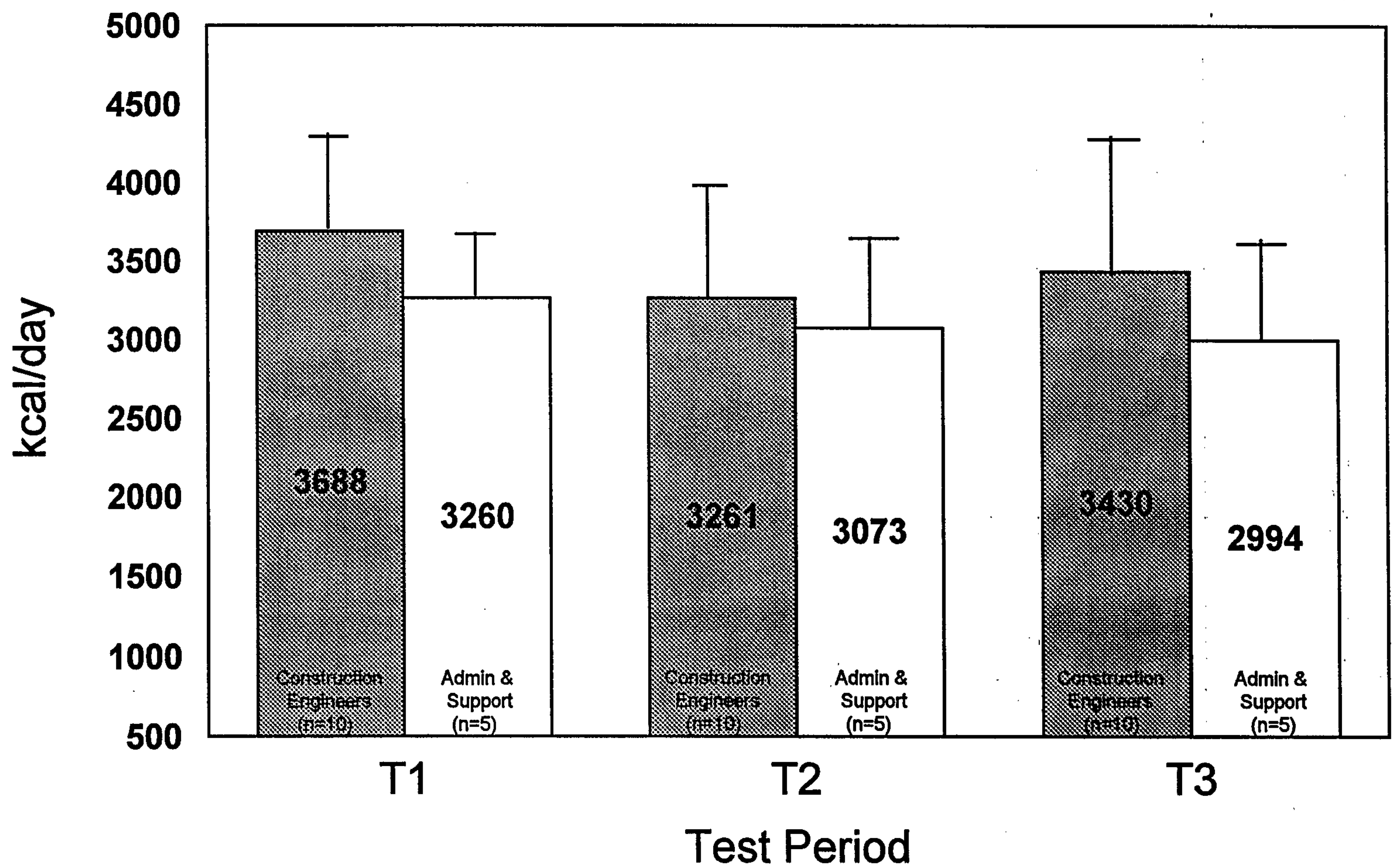
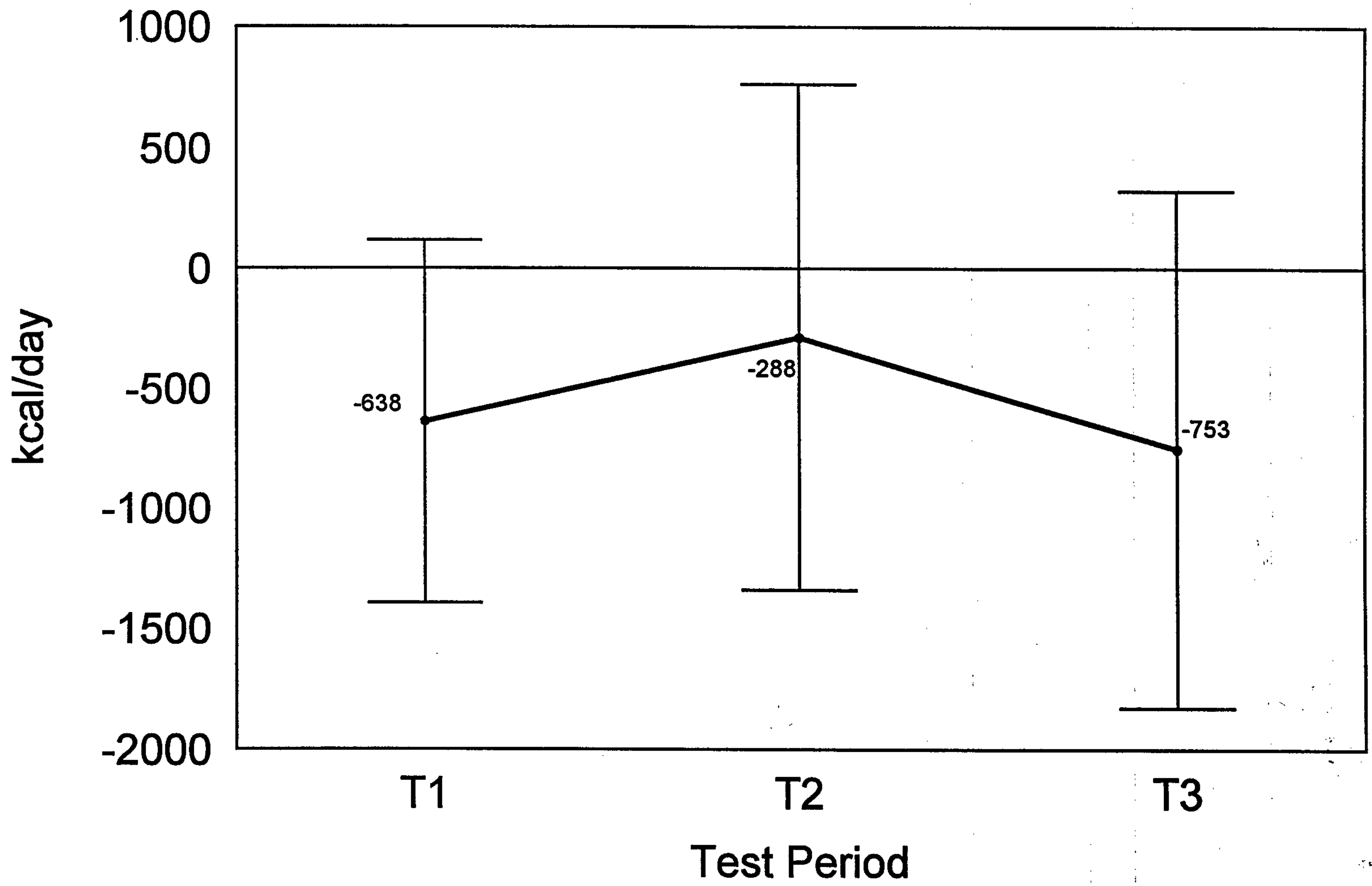


Figure 6.3. Energy balance over time for all volunteers (n=15).



Construction engineers had larger non-significant negative energy balances than administrative and support personnel throughout the study (construction engineers: -685 ± 1062 kcal/day vs. administrative and support personnel: -310 ± 708 kcal/day). Changes in energy balance over time by job type are shown in Figure 6.4. Figure 6.5 illustrates energy balance by job type and ration group during the three test periods.

Body Weight

No significant differences in body weight existed between ration groups of those in the DLW sub-sample. There were weight changes over time which were significant ($p < 0.0001$). Dunnett's test revealed that weight changes were significantly different from baseline beginning in Week 5 for the B Ration group and beginning in Week 6 for the T Ration group ($p < 0.01$). It was during these weeks that the weight losses exceeded the 3% criterion. By Week 8, weight losses averaged 5.1% (i.e., the greatest losses observed during the study) for both groups. Table 6.2 shows absolute mean weekly body weights and associated percent weight gains or losses compared to baseline weight.

Total Body Water (TBW) and Water Turnover

There were no differences between ration groups in TBW (Table 6.3) with values averaging 45.8 ± 4.7 kg for all individuals over the three test periods. However, TBW significantly decreased over time ($p < 0.0001$) (see Figure 6.6). While not statistically significant, construction engineers had larger TBW values than the administrative and support personnel (construction engineers: 47.0 ± 5.2 kg vs. administrative and support personnel: 43.8 ± 4.6 kg).

Examination of water turnover calculated from ^2H_2O elimination rates showed a slight decrease over time, but these differences were not significant (Figure 6.7). Average water turnover was identical for both ration groups and averaged 5.7 ± 1.0 L/Day. Water turnover rates by ration groups over time are shown in Table 6.3. A significant main effect between job categories showed that construction engineers had

Figure 6.4. Energy balance over time by job type (n=15).

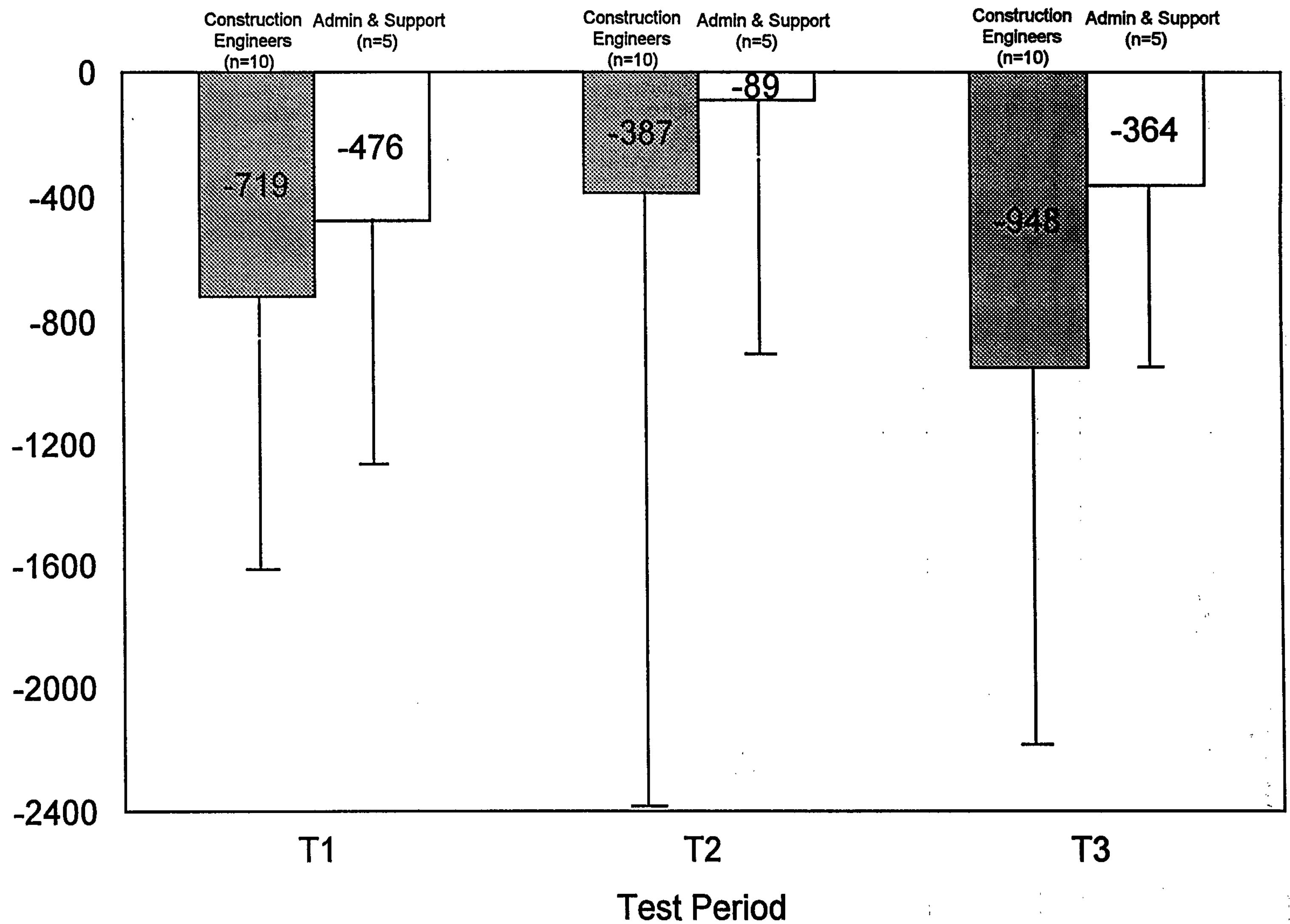


Figure 6.5. Energy balance by job type by ration group over time.

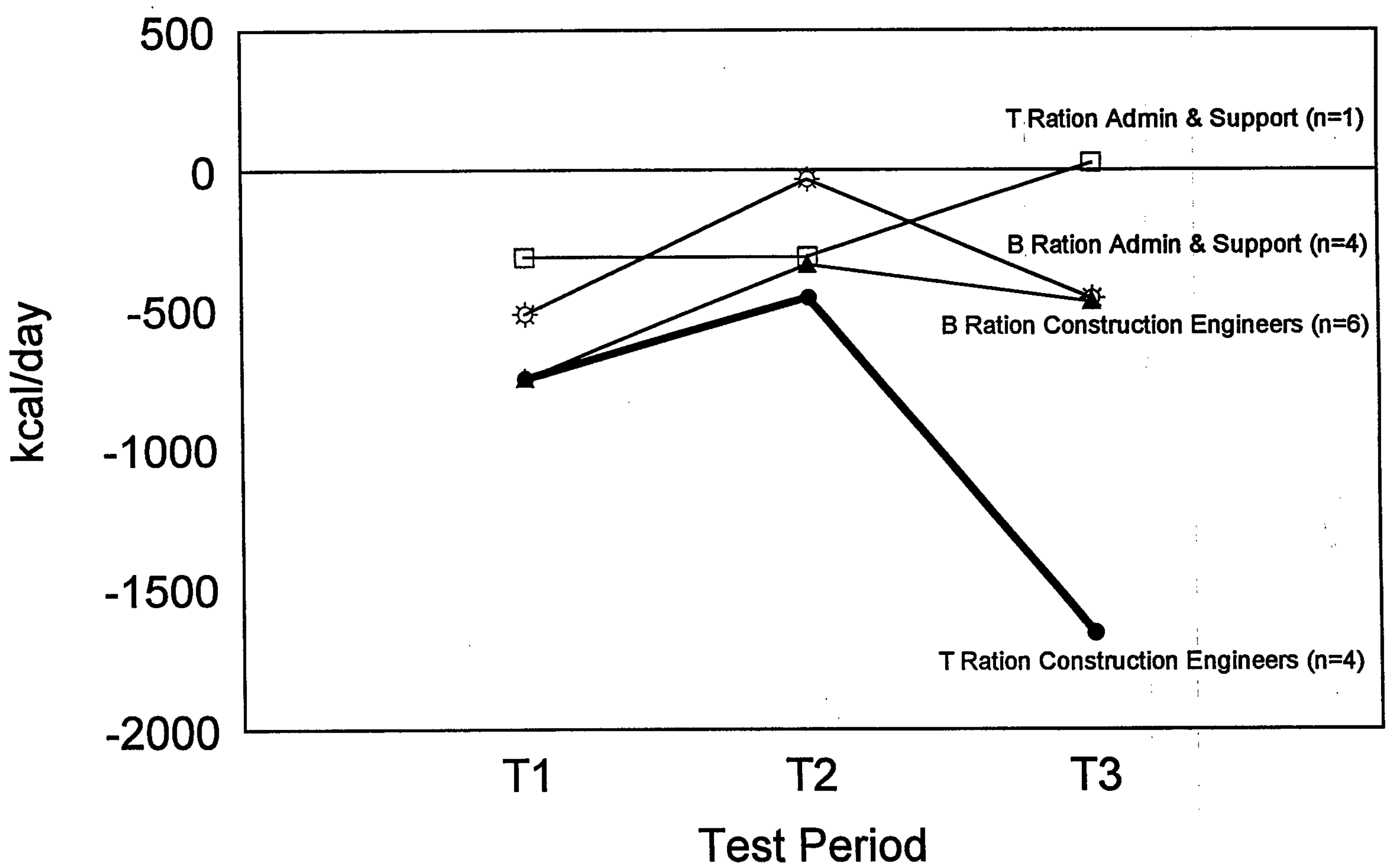


Table 6.2. Weekly body weights and percent changes from baseline weight by ration group.

	T Ration (n=5)		B Ration (n=10)	
	Weight (kg)	Percent Change From Baseline	Weight	Percent Change From Baseline
Baseline	78.9 ± 16.5		81.1 ± 7.0	
Week 1	78.7 ± 15.2	-0.2%	80.5 ± 6.4	-0.7%
Week 2	80.1 ± 15.6	+1.5%	81.1 ± 6.4	0.0%
Week 3	79.0 ± 15.1	+0.1%	79.9 ± 6.3	-1.5%
Week 4	78.6 ± 14.7	-0.4%	80.8 ± 6.0	-0.4%
Week 5	78.5 ± 14.5	-0.5%	78.5 ± 5.3*	-3.2%
Week 6	75.9 ± 14.8*	-3.8%	77.6 ± 5.3*	-4.3%
Week 7	76.5 ± 14.4*	-3.0%	77.4 ± 5.4*	-4.6%
Week 8	74.5 ± 11.8*	-5.6%	77.0 ± 4.7*	-5.1%

* Weight significantly different from baseline weight at $p \leq 0.01$ using Dunnett's test.

Table 6.3. Total body water (TBW) and water turnover by ration group over time.

	T1		T2		T3	
	T Ration (*n*=5)	**B Ration** (*n*=10)	**T Ration** (*n*=5)	**B Ration** (*n*=10)	**T Ration** (*n*=5)	**B Ration** (*n*=10)
TBW (kg)	45.4 ± 8.8	48.2 ± 3.4	44.2 ± 7.5	46.2 ± 3.1	44.1 ± 6.7	45.3 ± 3.7
Water Turnover (L/Day)	6.2 ± 1.6	5.8 ± 0.6	6.0 ± 1.5	5.6 ± 0.7	5.5 ± 1.1	5.5 ± 1.0

Figure 6.6. Total body water (TBW) over time for all volunteers (n=16).

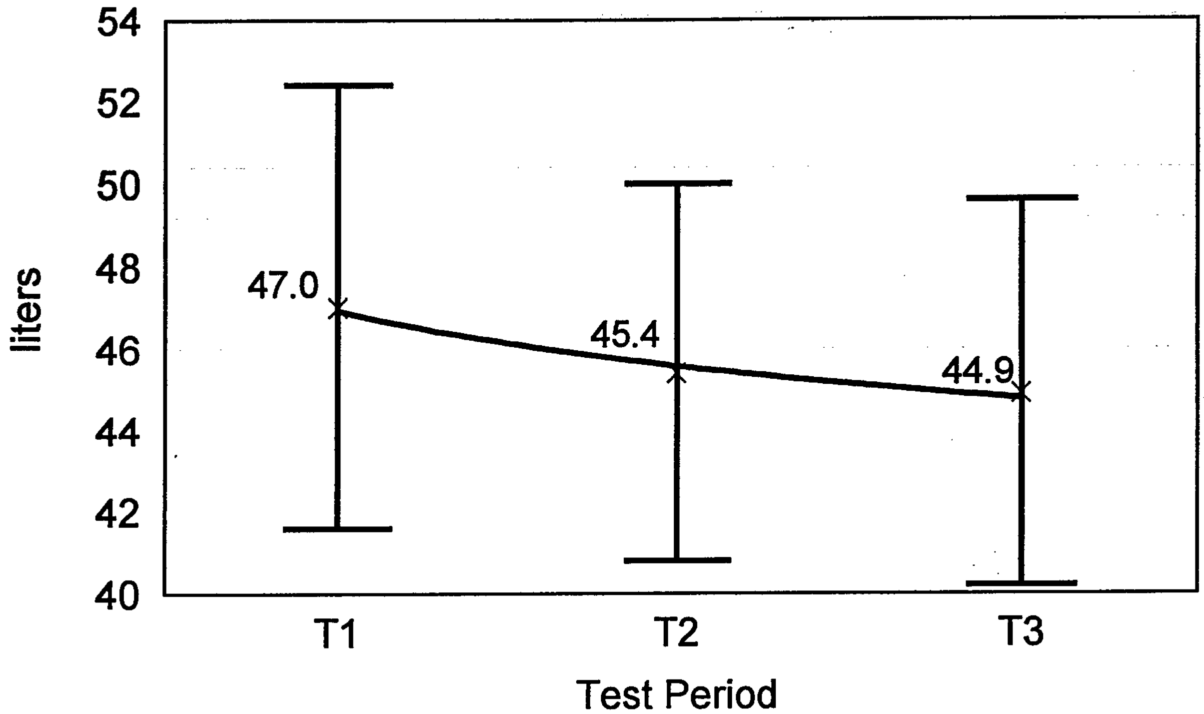
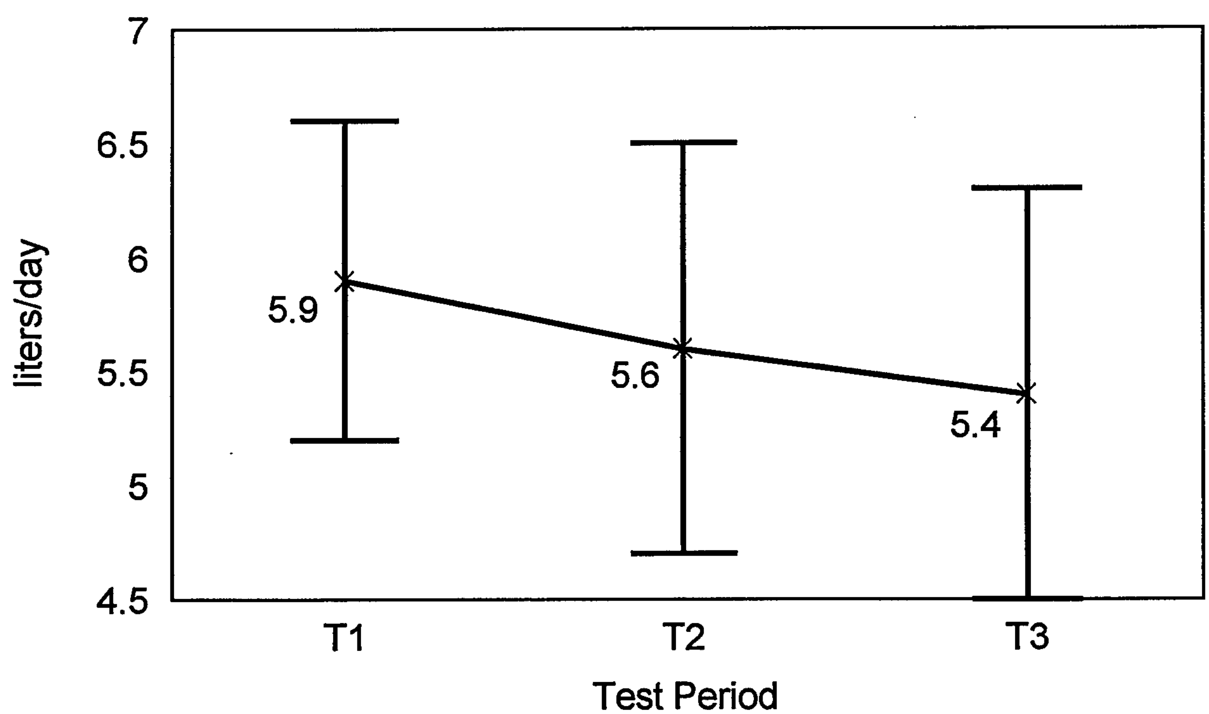


Figure 6.7. Water turnover rates over time for all volunteers (n=16).

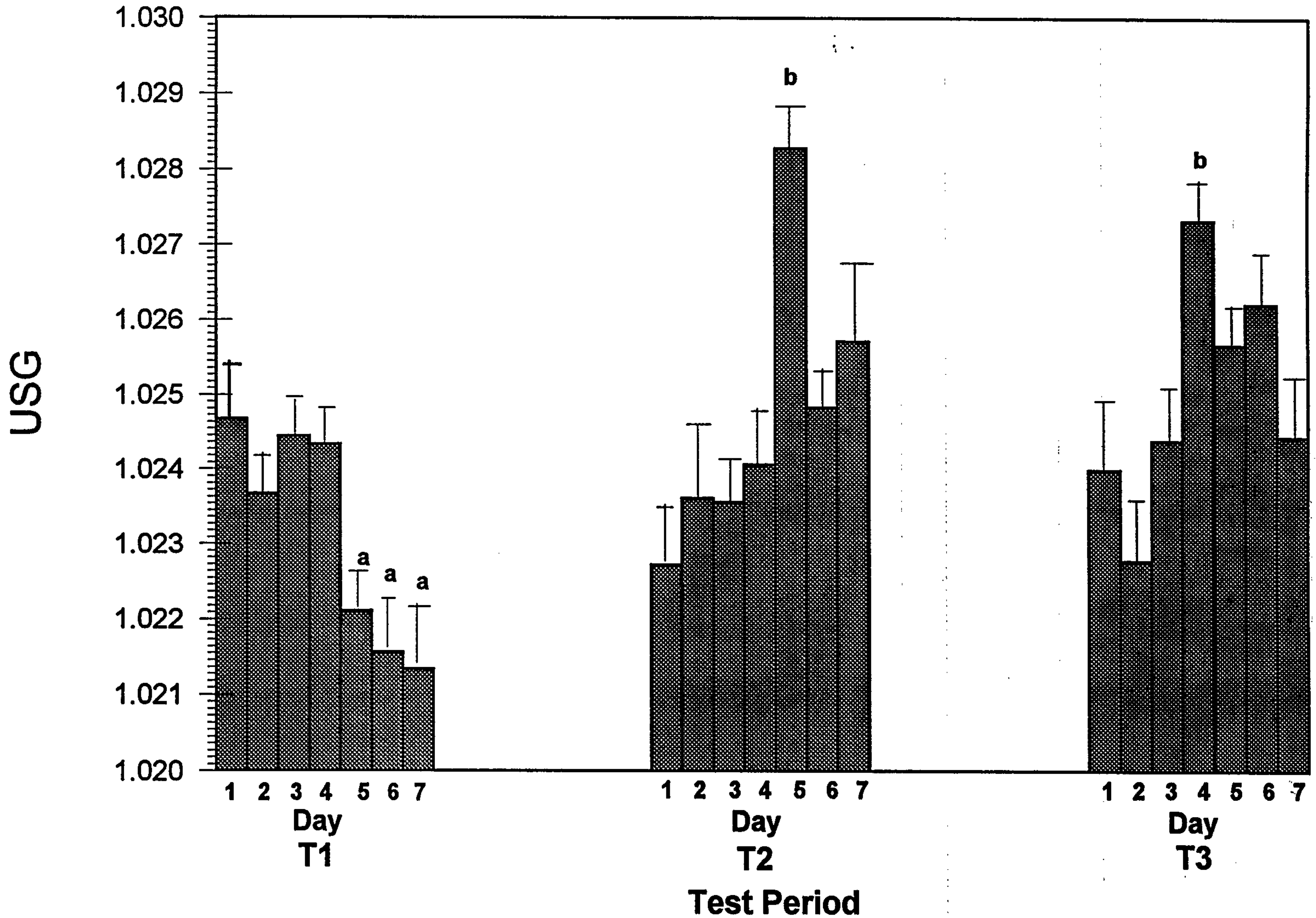


significantly greater water turnover rates than administrative and support personnel (construction engineers: 6.0 ± 0.9 L/Day vs. administrative and support personnel: 5.0 ± 0.8 L/Day).

Hydration Status Estimated From Urine Specific Gravities (USG)

Changes and differences in USG were examined between ration groups and across the 7 days within each test period as shown in Figure 6.8. There were no main effect differences in USG ($p > 0.05$) between T Rations: 1.025 ± 0.006 vs. B Rations: 1.024 ± 0.005, and no interaction effects (i.e., ration differences over time). A significant main effect of days was observed ($p < 0.05$) (see Figure 6.8) Differences between test periods also showed that the mean T1 USG (1.023 ± 0.006) was significantly lower ($p < 0.05$) than mean USG of both T2 (1.025 ± 0.006) and T3 (1.024 ± 0.006). There were no differences in USG between job types.

Figure 6.8. Urine specific gravity (USG) for all volunteers (n=18) over time.



* Those values with different letters are significantly different from one another at $p<0.05$ using Tukey's test.

DISCUSSION

Energy Expenditure

Energy expenditures were the greatest during T1, most likely because of the physically demanding tasks of unloading equipment and supplies coupled with the digging of the foundation during this first week. An increase in TDEE at T3 resulted as the Marines completed their building projects and prepared to leave. There were no differences in TDEEs between the two ration groups. Average energy expenditure (3328 kcal/day) was less than the 3600 kcal/day Nutritional Standard for Operation Rations (NSOR), suggesting that this standard is adequate for moderately active Marines in normal field missions.

Perhaps part of the non-significant differences between ration groups seen in Table 6.1 in energy expenditures was because 4 of the 5 (80%) of those consuming T-Rations were construction engineers vs. 6 of 10 (60%) of those consuming B Rations were construction engineers. A difference in energy expended between various job categories occurred. Construction engineers expended approximately 350 kcal/day more than those in the other job specialties. This difference in energy requirements suggests that basic daily food allowances may need to be adjusted to specific job categories.

Energy Balance

Those consuming the T Ration were in a greater negative energy balance (-784 kcal/day vs. -448 kcal/day, respectively) than those consuming the B Ration over the course of the study. The average energy deficit of -560 kcal/day in these Marines was similar to the energy deficit observed in a group of Special Forces (SF) soldiers participating in a 30-day field exercise in a temperate environment (1). From Figure 6.5 it may be seen that the negative energy balance was particularly high during T3 (i.e., over 1600 kcal/day) for the physically active construction engineers consuming the T Ration compared to construction engineers consuming the B Ration or administrative and support personnel consuming either ration. As time went on, a decrease in consumption by the T Ration Group (see Chapter 4) occurred. For the more physically active construction engineers in the T Ration group, this reduced consumption of all sources of food explains the decreased energy intake which, in turn, increased their negative energy balance. This reduced consumption also coincided with a higher level of energy expended in T3, as the final push to complete the construction project and to pack the equipment for the return to Camp Lejeune occurred. Although these results are based on data from a few subjects, they strongly suggest that for those with high levels of TDEEs, long-term consumption of the T Ration is likely to produce unacceptable weight losses.

The ratio of energy intake to energy expenditure for the entire time period was 78% for those consuming T Rations and 88% for B Rations. These ratios are similar to the 85% ratio calculated in the previously mentioned SF study (3). The T Ration ratio from this study was also similar to that observed with a Marine artillery unit fed the Unitized Group Ration (UGR) (79% ratio) (25) and soldiers participating in an arctic warrior field training exercise fed the 18-Man Arctic Tray Pack Ration Module (78% ratio) (15). In contrast to these findings, studies in the cold and/or at high altitude have reported much lower ratios between 52% and 64% (3,6,7,8,14,18). The data from this study suggest that short term use of either the B or T Rations in temperate to tropical environments is probably adequate and not as problematic as feeding soldiers or Marines in cold or at high altitude environments. However, caution should be exercised in the extended use of these rations because of the energy balance deficits observed. Prolonged energy deficits could pose health or performance problems for military personnel, as has been previously discussed (3,24).

Body Weight

Table 6.2 shows that the sub-sample of volunteers who participated in just the energy expenditure portion of the current study showed a greater percentage of weight loss from pre-deployment levels than the entire sample (see Table 3.2 in Chapter 3). Weight loss for the B Ration group exceeded the 3% weight loss criterion (28) by Week 5 (Day 35), and for the T Ration group exceeded the criterion by Week 6 (Day 42). These results are similar to the overall group in that there were no differences between ration groups. However, feeding either B or T Rations for extended periods of time may produce weight losses in excess of desired levels.

Hydration Status

The type of ration consumed had no effect on hydration status. Water turnover, TBW and USGs were not significantly different between ration groups. Test periods T2 and T3 had higher USGs corresponding to increased daily ambient temperatures (see Chapter 2). The USGs in this study were slightly higher than those of Marines participating in an artillery exercise in a desert environment (25). The principal difference between these two studies was the overall higher average daily temperatures in the Bahamas. The average daily day-time temperature was around 28°C compared to 24°C on the artillery desert exercise study.

Total body water decreased over time, but this was related to overall body weight loss and not an increase in proportional water loss. Those assigned to the construction jobs tended to be larger individuals possessing greater TBWs. Water turnover was approximately a liter more per day for construction engineers compared to administrative and support personnel, indicating fluid requirements were greater for the construction engineers. Water turnover rates have been shown to vary based on job types, environment, and body size (26). Water turnover rates of between 5.4 and 5.9 L/day indicate that for this tropical environment (see Chapter 2 for data concerning daily environmental conditions), fluid intakes were adequate but not generous.

The USG on Day 5 of T2 and Day 4 of T3 was significantly higher than all other days. The T2 Day 5 (May 6) mean USG of 1.0283 showed that these Marines were at risk of dehydration. Causes for potential dehydration were the high ambient temperatures (see Table 2.5 in Chapter 2) and high direct and indirect solar radiation levels (noon time values exceeded 1000 watts/m^2) coupled with physical exercise and lack of fluid consumption. Compounding the problem was that when Marines were on liberty or doing physical training away from base camp, access to fluids was difficult. The island did not have potable water readily available; when away from the base camp drinking water had to be carried or purchased. There were no drinking fountains, hoses or other potable water sources even in the downtown parks and beach areas where many of the Marines went during liberty.

CONCLUSIONS

- Average TDEE during this construction mission was 3328 kcal/day. Construction engineers expended more energy than administrative and support personnel. Current ration policy (NSOR) provides sufficient energy (3600 kcal/day) to meet the demands of combat engineers performing this type of mission.

- Negative energy balances were the greatest for construction engineers consuming T Rations. As time progressed these negative energy balances increased. The long term use (2 months or greater) of either T or B Rations would lead to sustained energy deficits, which may eventually lead to health or performance deficits.

- Weight loss in the volunteers in the sub-sample described in this chapter were greater than those of all volunteers. Weight losses exceeded 5% for both ration groups by the end of the study with the consumption of either two T or B Rations and a MRE per day. For the T Ration group, these weight losses are most likely associated with dislike of the rations and/or boredom associated with frequent serving of the same ration items. For the B Rations, the dislike or boredom with foods is exacerbated when key ingredients run out, and may account for the reason why a 5% level of weight loss was seen. Logistical planning should insure for sufficient supply of all items to guard against preparation of unpalatable food and subsequent underconsumption of rations. This underconsumption could result in undue weight loss, regardless of type of ration served.

- While the Marine leadership continually stressed the importance of fluid consumption, the difficulty of individuals obtaining and consuming sufficient fluids while away from base camp was a problem. The education of every soldier and Marine on the importance of fluid consumption and the consequences of hypohydration needs to continue. Special emphasis needs to be placed on the adequate consumption of fluids while on liberty, particularly in scenarios where high temperatures exist but local drinking water is not available. Personnel need to be instructed to carry fluids with them.

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CHAPTER 7

ACTIVITY AND SLEEP MONITORING

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INTRODUCTION

LaPorte et al. (4) found that although activity monitors do not yield a direct estimate of energy expenditure, total activity counts are closely related to the level of physical activity. The use of actigraphic data to assess sleep vs. waking state of humans has been demonstrated previously (8,9). Currently, the best algorithm to predict sleep vs. wake status is 90% accurate when validated against conventional polysomnographic sleep scoring (5,9). Activity monitors provide a measure of day-to-day patterns of sleep, rest and activity for comparison of work-rest cycles, length of the work day, length of the awake day and, during this study, the effect of consuming a particular type of ration.

Activity and sleep monitoring has been used to access the length of the work day and various levels of work activity of military personnel while deployed to the field. Marines participating in mountain warfare training exercises (3), soldiers during exercises at high altitude (2), Ranger training (7), and during artillery exercises in the desert (6) all have recorded activity and sleep records while volunteers participated in their training exercises unrestricted. While accurate energy expenditure measures are not available with activity monitors, they do allow for recording the nature of activity (i.e., whether it is continuous or stop-and-go). The use of these devices coupled with the doubly labeled water (DLW) method of assessing total daily energy expenditure (TDEE) provides accurate information on both the level and nature of the activity patterns of free-living humans engaged in physical activity.

METHODS

Motion logger Actigraphs, models BMA-32 (Precision Control Devices, Ft. Walton Beach, FL) were used to assess patterns of rest and activity (including work-rest cycle), total physical activity, and duration and fragmentation of sleep. Since sufficient monitors were not available for all test volunteers, only the volunteers who participated in the DLW portion of the study (see Chapter 6) wore the monitors.

The devices are 4 cm in length x 3.1 cm in width x 1 cm in height, weigh 57 g and are worn on the wrist of the non-preferred hand using a standard wristwatch band. Each device contains a microcomputer, 32k of memory, an analog-to-digital (A/D) converter and a piezoelectric sensor. To obtain high fidelity, the monitors sample total activity counts in 1 minute blocks of time. They are powered by standard wristwatch batteries and can record continuously up to 21 days. Figure 7.1 displays an example of the BMA-32 monitor. Data collected by the monitor was downloaded to a laptop computer for further analysis using the ACTION3 computer program (Ambulatory Monitoring, Inc.; Ardsley, NY).

Selected volunteers wore a monitor during three 5-day (7 days for T1) periods of time (T1, T2, and T3). The complete testing schedule is outlined in Table 1.1 in Chapter 1. The monitors were collected from the test volunteers after each test period, the data downloaded, and the monitors returned to the volunteers at the beginning of the next data collection period.

Data Analyses

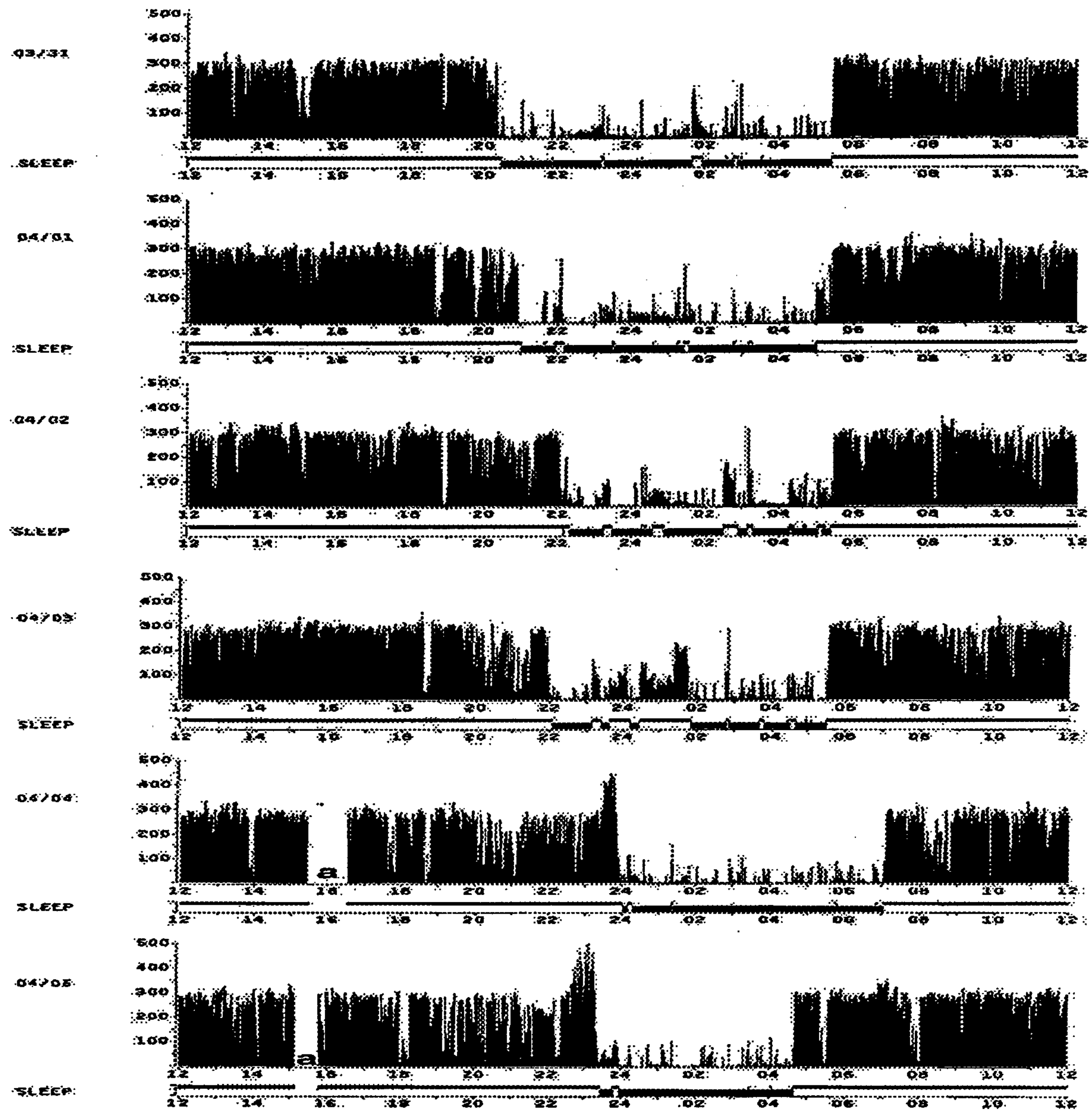
Initially, the data were downloaded by PCDGraph to produce a raw data file consisting of the volunteers' daily activity and sleep events over the duration of the study. These data files were then imported into Action3, which scores the individual Actigraph records for a sleep/wake state based upon a pre-programmed, empirically derived sleep scoring algorithm. For purposes of interpretation and analysis, the data are presented as 24-hour noon-to-noon intervals for the duration of each phase of the study. There were 7 days included from T1 (Days 1-7); 5 days from T2 (Days 33-37); and 5 days from T3 (Days 54-58).

Figure 7.1. The Actigraph Mini Motionlogger BMA-32 Monitor.

Only nighttime sleep periods were utilized for the sleep analyses. The data derived from these periods included total hours of sleep period opportunity, number of hours of sleep during the opportunity, minutes spent awake within the sleep event, and the number and average duration of the sleep disturbances or awakenings after sleep onset. From these statistics, additional sleep data were derived: sleep and wake percentages, minutes of sleep-to-awake ratio, and latency to sleep onset. Figure 7.2 illustrates an example of the daily pattern of rest and activity as recorded by the Actigraph monitors.

Data were analyzed for statistical significance between the two diet groups (T vs. B Ration) and over time (T1, T2, T3) using analyses of variance (ANOVAs). Tukey's post hoc testing was used to isolate individual differences in means over time ($p \leq 0.05$). Descriptive statistics are presented as means and standard deviations. There was a substantial amount of missing or invalid data for many volunteers accounting for a reduced volunteer number used in the analyses (T1: B Ration n=9; T Ration n=7; T2: B Ration n=6; T Ration n=2; T3: B Ration n=4; T Ration n=2). The main reasons for invalid data were removal of the monitor for an extended period of time (longer than 30

Figure 7.2. Example of Actigraph record of daily patterns of rest and activity in a Marine volunteer.



Each vertical line plotted on the x-axis represents the summed total amount of movement exhibited by the wearer in a 1-minute period of time. Each individual plot represents a 24-hour period starting at 1200 hours on the indicated date. Below each plot is estimated sleeping vs. waking time. The thicker, lower bar nearer to the x-axis indicates when the subject's activity is characteristic of sleep. The estimates of sleeping vs. waking are generated automatically by the *Action3* software using a validated algorithm. The gaps in the data recorded indicated by the letter "a" represent a period of time when the volunteer had removed the monitor.

minutes) or a mechanical malfunction. Volunteers were instructed to remove the monitors only before showering, when swimming, or during any other activities where the wrist could be immersed in water. However, while they were instructed to replace them immediately after these activities, many times they did not, thus leading to invalid or missing data. To account for this, weighted averages for each volunteer for each time period were used based on the number of valid days worth of data collected by a volunteer.

RESULTS

Activity Levels

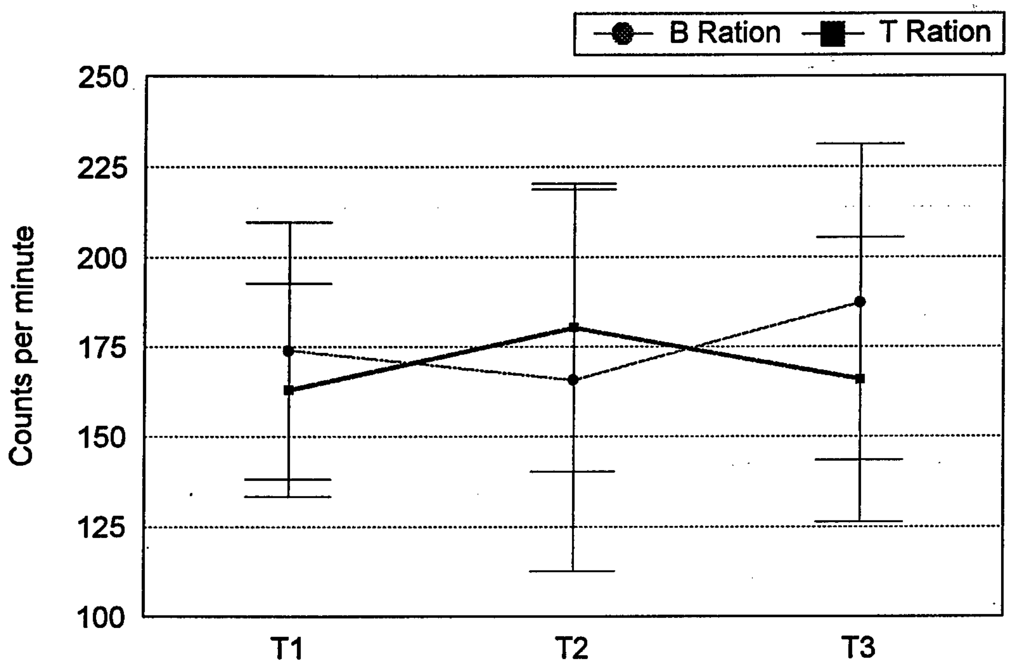
Both groups averaged a similar number of non-sleeping hours over all three test periods. A significant effect was found ($p \leq 0.01$) over time (T1: 15.9 ± 1.6 hrs, T2: 17.1 ± 2.3 hrs, T3: 16.2 ± 1.7 hrs). Post hoc testing revealed differences between T1 and T2 were significant ($p \leq 0.05$).

A significant interaction effect ($p \leq 0.05$) was found in average activity level (counts per minute) between ration groups over time. Figure 7.3 displays the differences in the activity levels between groups over time. The B Ration group was slightly more active at T1, decreased slightly at T2, and then increased at T3. The exact opposite occurred for the T Ration group. Similar results were observed with TDEEs for these two groups (see Chapter 6).

Sleep Quantity

Both groups averaged the same number of total sleep hours (TSLP) during T1. During both T2 and T3, the T Ration group slept slightly more, although these differences were non-significant. Means for this sleep measure and all sleep measures are presented in Table 7.1. A significant effect was found ($p \leq 0.01$) in TSLP over time (T1: 8.1 ± 1.6 hrs, T2: 6.9 ± 2.3 hrs, T3: 7.8 ± 1.7 hrs). Post-hoc testing revealed differences between T1 and T2 ($p \leq 0.05$).

Figure 7.3. Activity counts per minute by ration group over time.



The average sleep period was consistent across all test periods. A significant effect was found ($p \leq 0.01$) between groups (T Ration: 6.9 ± 1.6 hrs, B Ration: 6.1 ± 2.2 hrs).

Significant effects were found between groups (T Ration: 1.0 ± 0.7 hrs, B Ration: 1.4 ± 1.4 hrs, $p \leq 0.001$) and over time (T1: 1.4 ± 1.2 hrs, T2: 0.9 ± 0.7 hrs, T3: 1.7 ± 1.6 hrs, $p \leq 0.05$) in the average number of hours the volunteers were awake during their TSLP. The B Ration group was awake consistently longer than the T Ration group across all three test periods. Differences between T1 and T2 as well as T2 and T3 were significant ($p \leq 0.05$), but not for T1 and T3.

Sleep Quality

The quality of sleep, defined as percentage of sleep obtained during the volunteers' TSLP, differed significantly between groups (T Ration: 87.4 ± 9.1%; B Ration: 80.6 ± 17.2%, $p \leq 0.001$).

Sleep Fragmentation

Fragmentation of sleep, measured by number of awakenings per night, showed no differences between ration groups or over time. A significant effect ($p \leq 0.01$) of duration of fragmented sleep (measured in minutes) was found between groups (T Ration: 5.0 ± 3.8 mins, B Ration: 7.0 ± 6.3 mins). There were no significant effects with regard to the latency of sleep onset. All volunteers averaged about a 25-30 minute delay from the beginning of their TSLP to begin sleep.

Table 7.1. Sleep measure means and standard deviations.

Sleep Variable	Ration Group	Test Period			Overall Group
		*T1**[1]	*T2**[2]	*T3**[3]	
Total Sleep Period (hrs) †[1]	B	8.1 ± 1.5	6.7 ± 2.5	7.7 ± 1.9	**7.6 ± 2.0**
(TSLP)	T	8.1 ± 1.6	7.2 ± 1.9	8.1 ± 0.9	**7.9 ± 1.6**
	Overall Phase	**8.1 ± 1.6[a]**	**6.9 ± 2.3[b]**	**7.8 ± 1.7[a,b]**	
Sleep Hours †[2]	B	6.5 ± 2.0	5.8 ± 2.5	5.6 ± 2.2	**6.1 ± 2.2**
	T	7.0 ± 1.7	6.6 ± 1.6	7.4 ± 0.9	**6.9 ± 1.6**
	Overall Phase	**6.7 ± 1.9[a]**	**6.0 ± 2.3[b]**	**6.1 ± 2.1[b]**	
Wake Hours †[3, 4]	B	1.6 ± 1.5	0.9 ± 0.7	2.1 ± 1.7	**1.4 ± 1.4**
	T	1.1 ± 0.7	0.7 ± 0.7	0.7 ± 0.3	**1.0 ± 0.7**
	Overall Phase	**1.4 ± 1.2**	**0.9 ± 0.7**	**1.7 ± 1.6**	
Sleep Percentage †[4]	B	80.3 ± 17.9	84.3 ± 12.1	72.8 ± 22.2	**80.6 ± 17.2**
	T	85.8 ± 9.4	91.6 ± 7.7	91.3 ± 4.2	**87.4 ± 9.1**
	Overall Phase	**82.7 ± 15.0**	**86.4 ± 11.5**	**77.9 ± 20.7**	
Number of Awakenings	B	12.5 ± 6.7	11.9 ± 6.4	13.6 ± 6.3	**12.5 ± 6.5**
	T	14.0 ± 7.3	9.4 ± 4.5	11.8 ± 4.6	**12.9 ± 6.9**
	Overall Phase	**13.2 ± 7.0**	**11.2 ± 6.0**	**13.1 ± 5.8**	
Duration of Awakenings (mins)†[2]	B	7.5 ± 7.3	5.1 ± 2.9	9.3 ± 7.2	**7.0 ± 6.3**
	T	5.6 ± 4.2	3.4 ± 2.3	3.5 ± 0.7	**5.0 ± 3.8**
	Overall Phase	**6.6 ± 6.2**	**4.6 ± 2.8**	**7.7 ± 6.6**	
Sleep Latency (mins)	B	32.2 ± 21.6	33.8 ± 27.4	25.2 ± 12.5	**31.8 ± 22.7**
	T	29.0 ± 15.7	26.7 ± 14.6	29.5 ± 32.7	**28.6 ± 17.0**
	Overall Phase	**30.8 ± 19.2**	**31.8 ± 24.5**	**26.4 ± 19.2**	

*[1] *B Ration n=9; T Ration n=7*
*[2] *B Ration n=6; T Ration n=2*
*[3] *B Ration n=4; T Ration n=2*
†[1] Difference over time, $p \leq 0.01$
†[2] Difference between groups, $p \leq 0.01$
†[3] Difference over time, $p \leq 0.05$
†[4] Difference between groups, $p \leq 0.001$
[a,b] Those with different letters are significantly different, $p \leq 0.05$ across test periods (T1, T2, T3).

DISCUSSION

Marines during this study slept an average 6.4 hours per day (6.7 hr during T1, 6.0 hrs during T2, and 6.1 hrs during T3). The sleep quantity and quality among these volunteers were consistent throughout the study, but were slightly less than that of Marines conducting artillery field exercises in a hot, desert environment where they slept 7.1 hrs per night (6). Soldiers sleeping in a barracks-like, climate-controlled environment also slept for 7.1 hours while not wearing a chemical protective (CP) mask (5). The amount of sleep the Marines in this study received was considerably more than that received by soldiers participating in the U.S. Army Ranger Training Course (an average of 3.60 hours per night), where the amount of sleep is largely dictated by course requirements (7).

Environmental conditions (Chapter 2) were generally warm during the nighttime. The average temperature was 24.5° C (~76.1° F), and the relative humidity was 77.4%. Volunteers slept an average of 83.2% of the time they attempted to sleep. This is a lower percentage of time than volunteers in the previous Marine study conducted with the artillery unit slept. In that study, the average temperature at night was 10° C (~50° F), the relative humidity was ~ 30%, and the volunteers slept 92.9 % of the time they attempted to sleep (6). The quality of sleep of the volunteers in this study was also worse than soldiers participating in the Ranger Training studies. During Ranger I and Ranger II, soldiers slept between 85% and 89% of the sleep period (7). In comparison to the CP mask study, the Marines' sleep quality was worse than the 94.5% amount of sleep per sleep period the soldiers had when not wearing a CP mask, yet better than the 81% value when wearing the CP mask (5).

Sleep differences may have been compounded by the environmental conditions within which the Marines slept and the length of time they had spent previously in the field. The average number of waking hours during their total sleep period and the amount of fragmented sleep may have been influenced by the mosquitos and sand flies. Sleeping took place inside GP Medium shelters, where a lack of adequate airflow and an elevated ambient temperature from the body heat of 10-14 people in a tropical environment may have also disrupted sleep quantity and quality.

It should be noted that the significant differences revealed between groups may be the result of the influence of external factors not recorded by this analysis. The differences in non-sleeping hours and average daily activity levels may be attributable to the demographics and job duty of the test groups (Chapter 2). Of the volunteers in the B-Ration group, 83% (n=10) were construction engineers while 16% (n=2) were administrative or support personnel. Marines in the T Ration group were composed mostly of administrative or support personnel (56%, n=5) and only 44% (n=4) were construction engineers.

CONCLUSIONS

- The Marines maintained consistent levels of daily activity and non-sleeping hours.
- In general, the quantity and quality of sleep for the volunteers in this study was comparable to that observed previously.
- Environmental factors may have affected sleep.

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CHAPTER 8

PHYSICAL PERFORMANCE

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INTRODUCTION

Dietary restrictions combined with environmental factors can reduce physical performance. For example, consumption of *ad libitum* Meals, Ready-to-Eat (MRE) during altitude exposure for 12 days reduced maximal aerobic capacity by 5% and led to weight losses of 3% (1). A low level of carbohydrate (CHO) intake (260 g/day) was identified as a possible cause for the reduced aerobic capacity; the MRE has been changed substantially since that study. Weight losses of less than 5% appear not to compromise physical performance unless they are associated with dehydration, ketosis, or hypoglycemia, which can result from low CHO intake (8,10,16,17).

An evaluation of students participating in the Ranger Training Course reported weight losses of 15.6% over the 62-day course associated with a reduction of 23.5% in the maximal dynamic lift test (13). In a second study also with students at the Ranger Training Course, modest nutritional interventions to provide slightly more calories attenuated the weight losses to 13% of initial body weight. These weight losses were accompanied by a 20% reduction in maximal lifting strength (7). These and other studies demonstrated that chronic underconsumption leading to significant losses of skeletal muscle will elicit deficits in both work capacity (14) and muscular strength (8).

In a study evaluating the MRE VII (with a supplemental beverage powder pack) and the Ration Light Weight (RLW) for 30 consecutive days, no differences in performance were observed between the two groups, although there was a smaller

(2.2%) weight loss in the MRE group vs. the RLW group (6.3%). Aerobic capacity was affected, but the decline was attributed to the lack of training that occurred during the study (2). In an initial study wherein two tray pack rations (T Rations) and one MRE were consumed per day for 36 days, average weight losses did not exceed 2% of initial body weight, and there were no changes in muscle strength, muscular endurance, or eye-hand coordination (19). This chapter describes the effects of consuming T Rations for 60 days on dynamic muscular endurance and muscular power.

METHODS

An exercise history questionnaire was administered and completed by 51 volunteers prior to and at the end of deployment to obtain general information on physical activity (e.g., running/jogging, strength training, other sports and exercise activities, etc.). Differences in physical training and exercise while at Camp Lejeune vs. while deployed to Great Inagua, Bahamas, and differences between ration groups (T vs. B Rations) were examined. Description of both rations have been described elsewhere (18).

Up to 59 volunteers took part in the various physical performance tests. Differences in the number of volunteers are noted in the various tables throughout this chapter based on whether they completed the tests. There was an individual who had a lower extremity injury that precluded his participation in the vertical jump test, and two who had upper extremity injuries keeping them from the bench press and the arm curl tests.

An assessment of physical performance was made at each test period, T1, T2 and T3 of the study (See Table 1.1). Measurement at T1 was used to determine baseline fitness levels. T2 and T3 measures were used to determine changes in physical performance resulting from the construction mission and/or diet. The assessment included tests of muscular power and muscular endurance.

Muscular Power

Muscular power is commonly used to indicate the ability to release maximum muscular force in the shortest possible time (3). The most common power test used is the vertical jump (15) which uses the hamstrings and quadriceps muscles of the leg, as described below (6).

Sargent jump.

Muscle groups: hamstrings and quadriceps

Equipment: Vertec Vertical Jump Meter (Sports Imports, Columbus, OH)

Starting weight: body weight

Technique: Three trials of vertical jump performance were assessed using a counter-movement technique (5). The Vertec jump meter consists of a 24" vertical comb-like array of 49 evenly spaced horizontal vanes. These vanes easily pivot out of the way when they are touched. This array is atop a support that allows positioning from 6' to 12' above the floor. The volunteer stands directly underneath the Vertec with his/her heels together and reaches as far overhead as possible with one hand without lifting either heel off the floor. The Vertec is then adjusted so the bottom vane just touches the volunteer's outstretched hand. If the volunteer has a vertical jump that is greater than 24 inches, the bottom of the vane array can be raised a known distance above the volunteer's outstretched hand to accommodate the larger jump displacement.

The volunteer was instructed to jump as high as possible and to tap the measurement vanes at the top of his/her jump with his/her upward reaching hand. By touching the vanes, the volunteer leaves a temporary, resettable record of his/her jump and reach. The vanes serve as a target for the jumper and also serve as a motivator to encourage improved performance. The volunteer performs a countermovement jump without a jab step or a preparatory run. His/her maximal jump height was recorded, and the measurement vanes were reset. A minimum 45-second rest was given between each jump. Each volunteer performed 3 jumps per test session. All data were converted to centimeters (cm) for analysis and presentation.

Peak power was calculated using the best jump performance and the equation derived by Harman et al. (9):

Peak power (W) = (61.9 x jump height in cm) + (36.0 x body weight in kg) - 1,822. Body weight was the volunteers' weight during the week that corresponded to their jump test session.

Dynamic Muscular Endurance Tests

Dynamic muscle endurance can be evaluated by performing as many repetitions as possible using a weight that is a fixed percentage of the individual's body weight (11,15). The bench press and the arm curl (performed in that order with at least a 10 minute rest interval in between) were used to assess upper body muscular endurance. The above order of the tests allowed performance assessment from a large muscle to a small muscle, thus avoiding fatiguing the synergistic and supporting musculature necessary for producing proper technique in the large muscle movements. The following descriptions of the exercises were taken from Heyward (11).

Supine Bench Press.

Muscle groups: pectoralis muscles, shoulder flexors, triceps, and deltoids

Equipment: Olympic bar, weight plates, bar collars, and a weight bench with bar supports

Starting weight: 70% of body weight

Technique: Starting position: body aligned under bar, no exaggerated back arch, buttock remains in contact with bench at all times, feet flat on the ground.

Down phase: control speed, no exaggerated back arch, bar horizontal, lateral stability, bar touches chest, no bouncing off the chest.

Up phase: no exaggerated back arch, bar horizontal, lateral stability, full even elbow extension, continuous motion (no resting in the elbow extension position), feet flat on the floor.

*Repeated as many times as possible

Arm Curl.

Muscle groups: biceps, elbow flexors

Equipment: barbell curl bar, weight plates, bar collars

Starting weight: 35% of body weight

Technique: Starting position: Standing with elbows extended fully and in front of thighs; supinated grip, grip approximately shoulder width apart.

Up phase: Flex the elbows, raising the bar to the chest; without leaning backward or jerking the upper body to move weight; it is a continuous controlled motion (no resting in the elbow flex position).

Down phase: Return weight to starting position in a controlled manner, not allowing weight to fall uncontrolled (no resting in the elbow extended position).

*Repeated as many times as possible

Statistical Analyses

Results were analyzed for statistical significance between the two diet groups (T Ration vs. B Ration) and over time using a repeated measures analyses of variance (ANOVAs) with ration group as the grouping factor. Descriptive statistics are presented as means ± standard deviations. Statistical significance was set at $p \leq 0.05$.

RESULTS

Frequency of participation in jogging/running, strength training, stretching, or walking showed no significant differences between ration groups either prior to deployment or while deployed (Table 8.1). There were also no differences in exercise patterns for jogging/running, strength training, or walking between ration groups prior to or during deployment (Table 8.2). There were significant interaction effects of ration group by time (pre-deployment vs. during deployment) for both number of days/wk of stretching ($p < 0.02$) and mins/day of stretching ($p < 0.04$). From Table 8.2 it may be observed that the T Ration group increased their amount of stretching during deployment while the B Ration group decreased their amount of stretching. This pattern followed for both number of days/wk and mins/day.

There were no differences in any of the physical performance tests (i.e., no main effect of diet or a diet by time interaction). The vertical jump test (Table 8.3) did not show any significant changes over time for either jump height or peak power output. The effect of the construction mission had differentiating effects on the number of repetitions one could perform on the bench press vs. the arm curl test. On the bench press test (Table 8.4) there was a significant drop (p <0.003) in number of repetitions performed over time. Tukey's test indicated the significant difference ($p \leq 0.05$) was between T1 and T3. In contrast, the arm curl test (Table 8.4) showed a significant improvement ($p < 0.05$) over time with Tukey's test indicating the difference occurred in the first 30 days, while there was no difference in number of repetitions performed between T2 and T3.

Examining the association of body weight loss/gain (Chapter 3) and physical performance revealed significant relationships between weight loss/gain and the vertical jump and bench press measures during both T2 and T3 time periods (Table 8.5). If all volunteers are used in the analysis, as weight loss increases, performance on the vertical jump and bench press becomes impaired. However, when assessing those individuals with total weight losses exceeding either 3% or 5%, there were no significant correlations for these two measures. Those who had weight losses between 0% and 3% did slightly poorer on the vertical jump. Furthermore, the 11 volunteers who gained weight by T3 manifested a significant positive correlation in bench press performance and weight gain ($p < 0.05$). However, those who gained weight did poorer on the arm curl test ($p < 0.05$) (Table 8.6).

Table 8.1. Record of frequency of physical training before and during deployment by ration group (T Ration [*n*=17], B Ration [*n*=34], and Total Volunteers [*n*= 51]).

	PRE-DEPLOYMENT ACTIVITY				DURING DEPLOYMENT ACTIVITY			
	Yes		No		Yes		No	
	n	%	*n*	%	*n*	%	*n*	%
Running/Jogging								
T Ration Group	15	88.2	2	11.8	15	88.2	2	11.8
B Ration Group	29	85.3	5	14.7	28	82.4	6	17.6
All Volunteers	44	86.3	7	13.7	43	84.3	8	15.7
Strength Training								
T Ration Group	9	52.9	8	47.1	10	58.8	7	41.2
B Ration Group	18	52.9	16	47.1	23	67.6	11	32.4
All Volunteers	27	52.9	24	47.1	33	64.7	18	35.3
Stretching								
T Ration Group	10	58.8	7	41.2	10	58.8	7	41.2
B Ration Group	27	79.4	7	20.6	18	52.9	16	47.1
All Volunteers	37	72.5	14	27.5	28	54.9	26	45.1
Walking								
T Ration Group	9	52.9	8	47.1	9	52.9	8	47.1
B Ration Group	21	61.8	13	38.2	21	61.8	13	38.2
All Volunteers	30	58.8	21	41.2	30	58.8	21	41.2

Table 8.2. Exercise participation pre- and during deployment by ration group (T Ration [n=17], B Ration [n=34], and Total Volunteers [n=51]).

	ACTIVITY PRE-DEPLOYMENT				ACTIVITY DURING DEPLOYMENT			
	Days/Wk		Min/Day		Days/Wk		Min/Day	
	Total *n* Mean ± S.D.	(Valid *n*) Mean	Total *n* Mean ± S.D.	(Valid *n*) Mean	Total *n* Mean ± S.D.	(Valid *n*) Mean	Total *n* Mean ± S.D.	(Valid *n*) Mean
Running/Jogging								
T Ration Group	2.4 ± 1.2	(2.7)	37.1 ± 24.2	(42.0)	2.4 ± 1.5	(2.7)	32.5 ± 16.2	(36.8)
B Ration Group	2.6 ± 1.3	(3.0)	32.5 ± 19.5	(38.1)	1.9 ± 1.3	(2.3)	28.4 ± 17.0	(34.5)
Total Volunteers	2.5 ± 1.3	(2.9)	34.0 ± 21.1	(39.4)	2.1 ± 1.4	(2.5)	29.8 ± 16.7	(35.3)
Strength Training								
T Ration Group	1.7 ± 1.8	(3.2)	32.7 ± 36.1	(61.8)	2.0 ± 2.1	(3.4)	31.5 ± 32.1	(53.6)
B Ration Group	1.9 ± 2.1	(3.6)	34.1 ± 46.1	(64.4)	2.2 ± 1.8	(3.3)	39.7 ± 41.6	(58.7)
Total Volunteers	1.8 ± 2.0	(3.4)	33.6 ± 42.6	(63.5)	2.2 ± 1.9	(3.4)	37.0 ± 38.6	(57.2)
Stretching								
T Ration Group	1.9 ± 1.7	(3.2)	8.8 ± 8.9	(15.0)	2.4 ± 2.4	(4.1)	9.8 ± 14.3	(16.7)
B Ration Group	2.9 ± 2.0	(3.7)	15.3 ± 15.5	(19.3)	1.6 ± 1.8	(3.0)	8.1 ± 11.2	(15.3)
Total Volunteers	2.6 ± 1.9	(3.6)	13.2 ± 14.0	(18.2)	1.8 ± 2.0	(3.3)	8.7 ± 12.2	(15.8)
Walking								
T Ration Group	2.8 ± 3.1	(5.3)	29.1 ± 41.2	(55.0)	2.9 ± 3.2	(5.5)	42.4 ± 54.2	(80.1)
B Ration Group	3.7 ± 3.3	(6.0)	32.9 ± 38.0	(53.3)	4.1 ± 3.3	(6.6)	43.8 ± 48.5	(70.9)
Total Volunteers	3.4 ± 3.2	(5.8)	31.7 ± 38.7	(53.9)	3.7 ± 3.3	(6.3)	43.3 ± 49.9	(73.6)

* Total *n* includes all volunteers in the sample; i.e. those that did not participate in the activity have "0" values averaged into the sample mean. Valid *n* is the mean for only those volunteers in the sample who participated in the activity (See Table 8.1 for *n*).

Table 8.3. Vertical Jump (cm) and Peak Power (Watts) by ration group (T Ration [*n*=21], B Ration [*n*=38], and Total Volunteers [*n*=59]) at T1, T2, and T3.

	Baseline (T1)	30 Days in Field (T2)	50 Days in Field (T3)
Vertical Jump			
T Ration Group	51.8 ± 9.9	51.3 ± 7.4	53.1 ± 8.4
B Ration Group	51.1 ± 8.4	53.3 ± 8.1	52.0 ± 8.4
Total Volunteers	51.3 ± 8.6	52.6 ± 7.9	52.3 ± 8.4
Peak Power			
T Ration Group	4369 ± 196	4539 ± 430	4635 ± 456
B Ration Group	4397 ± 436	4799 ± 569	4302 ± 639
Total Volunteers	4382 ± 344	4669 ± 362	4469 ± 492

Table 8.4. Bench Press and Arm Curls (number of repetitions) by ration group (T Ration [*n*=21], B Ration [*n*= 36], and Total Volunteers [*n*=57]) at T1, T2, and T3.

	Baseline (T1)	30 Days in Field (T2)	50 Days in Field (T3)
Bench Press			
T Ration Group	18.3 ± 8.5	16.2 ± 9.0	16.1 ± 9.0
B Ration Group	17.1 ± 7.7	16.3 ± 8.0	15.4 ± 8.4
Total Volunteers	17.5 ± 8.4	16.3 ± 8.4	15.7 ± 8.5
Arm Curls			
T Ration Group	21.0 ± 7.2	22.4 ± 6.3	22.8 ± 7.4
B Ration Group	25.0 ± 9.1	26.8 ± 11.9	27.0 ± 11.0
Total Volunteers	23.5 ± 8.7	25.1 ± 10.7	25.5 ± 10.0

Table 8.5. Pearson correlation coefficients of performance measures and percent weight loss for all volunteers (n=59).

	Percent Weight Loss at 30 Days in the Field (T2)	Percent Weight Loss at 50 Days in the Field (T3)
T2 Vertical Jump	0.44**#	
T2 Power	-0.02	
T2 Bench Press	0.41*#	
T2 Arm Curls	0.24	
T3 Vertical Jump		0.44**#
T3 Power		-0.01
T3 Bench Press		0.44**#
T3 Arm Curls		0.33

* Correlation coefficient significant at $p \leq 0.05$; ** Correlation coefficient significant at $p \leq 0.01$.

\# As volunteers lost more weight they didn't jump as high, or bench press as many reps.

Table 8.6. Pearson correlation coefficients of performance measures and percent weight gain in volunteers who gained weight (n=11).

	Percent Weight Gain 30 Days in the Field (T2)	Percent Weight Gain 50 Days in the Field (T3)
T2 Vertical Jump	0.27	
T2 Power	0.44	
T2 Bench Press	0.57*	
T2 Arm Curls	-0.67*	
T3 Vertical Jump		-0.18
T3 Power		0.33
T3 Bench Press		0.43
T3 Arm Curls		-0.51

* Correlation coefficient significant at $p \leq 0.05$; ** Correlation coefficient significant at $p \leq 0.01$.

\# As volunteers gained more weight they bench pressed more reps but they arm-curled less reps.

DISCUSSION

Peak power output (4469 W) obtained from the vertical jump test was similar to Division 1 Final Four male volleyball players (4456 W), although the volleyball players measures were done without an arm counter-movement which does increase power output (12). Vertical jump height and peak power output were greater than students attending Ranger Training School or the Special Forces Assessment and Selection (SFAS) Course. In the Ranger study, vertical jump with a counter-movement was 48.0 ± 7.4 cm (mean ± S.D.) before the start of the course and decreased to 39.9 ± 6.2 cm at the end of the course, showing a significant decrease in jump height (-16%), while peak power went from 3972 ± 561 watts to 3119 ± 479 watts (-21%) (7). The SFAS study showed similar results: jump height decreased from 47.0 to 45.5 cm, a 3.1% decrease. Peak power also decreased from 3887 ± 477 watts to 3667 ± 480 watts, a 7.0% decrease (5). The volunteers on this study actually showed a small (2%) increase in jump height and peak power output after 50 days of participation in a construction mission and living and eating in the field. No differences in jump height or peak power output were seen based on the type of ration consumed.

The number of bench press repetitions completed with 70% of one's body weight was similar to two previous studies that used similar but slightly different lifting protocols (4,20). The arm curl test as was used in this study has not been used previously. There were no differences in performance between ration groups for either the bench press or the arm curl tests. Significant differences existed over time. Marines were able to do more arm curls and less bench press lifts over time. The most plausible explanations are that for the arm curl test, the work involved in repetitively lifting building materials served as a cross-training activity, as the same muscle groups (biceps) are involved in both types of exercises. Conversely, the poorer performance on the bench press probably resulted in the lack of training the specific muscle groups in that activity (pectoralis muscles, shoulder flexors, triceps, and deltoids) while working in the field. From Table 8.2 it appears that no differences in the amount of strength training occurred during deployment to the field compared to when stationed at Camp Lejeune. However, there was only free weights, a bench press bench and bar, and an arm curl bar. It is possible that many of the Marines who used weight machines at Camp Lejeune did not train as hard on the equipment in the field, and their performance on our criterion task which is subject to training effects, suffered as a result. The information from the exercise participation questionnaire yielded some information on the quantity of overall strength training, but it did not provide information on the quality or the specific exercises.

In general, weight loss did not affect physical performance, while weight gain had different effects on the bench press and arm curl tests. Those with weight gain performed better on the bench press and poorer on the arm curl test. The most logical explanation is that for the bench press, which involves a number of larger muscle groups, those who gained weight probably put on muscle mass through specific training. Those same individuals probably did not train as specifically for the arm curl test. Those who worked out most vigorously in the weight room worked the major muscle groups, with the most typical exercises performed being the bench press, dead lifts and squats. While consumtion of the T Ration did not specifically limit physical performance, these results suggest that muscle building is difficult when losing weight, no matter what the ration provision.

CONCLUSIONS

- There was no decrement in physical performance as a result of eating T Rations.
- Weight losses of up to 5% did not affect physical performance.
- Vertical jump and calculated peak power output in this Marine sample exceeded other recently tested military units and was similar to that observed in college volleyball players.
- Bench press repetitions decreased over time probably due to the lack of specific training by many Marines due to the limited lifting facilities in the field.
- Arm curl repetitions increased over time, probably as a side benefit of lifting building materials on the job, which was a task that was similar in nature.

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CHAPTER 9

MOOD STATES

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INTRODUCTION

Meal-time for deployed soldiers often provides the only reprieve from either the boredom or stress of their combat or training missions. Trained cooks often provide special meals as a motivational tool to improve the morale of deployed troops. Mood can be influenced by meal composition as well as individual food constituents, combined with a variety of mediating factors such as exercise, time of day, nutritional status, and amount of sleep (8,12). Previously, mood has not been shown to be negatively affected while consuming the Unitized Group Ration (UGR) for 11 days (14). This UGR had many of the same foods as the current T Ration. However, mood changes due to repeated exposure to the same menu cycle for an extended period of time (60 days) has not been studied.

The importance of mood state in the performance of heavy exercise or continuous endurance exercise has been widely studied in the sport psychology literature (10). Those exhibiting higher levels of vigor and lower levels of various negative moods are more likely to perform better at physical tasks (1,10). Continuous heavy physical exertion can produce negative moods, which in turn can negatively affect subsequent physical performance. Morgan (10) has reported that increases in negative mood states resulting from prolonged repetitive bouts of physical work can be used as a measure of what he terms "physical staleness." The lack of proper nutrition may exacerbate negative moods resulting from strenuous work. The importance of maintaining a positive mood state is well documented in sports performance (10).

Additionally, other studies on cognitive functioning have reported that negative moods are correlated with a decrease in task-related decision making capability (4) and problem solving (5). It is reasonable to hypothesize that mood could affect work performance during construction projects.

METHODS

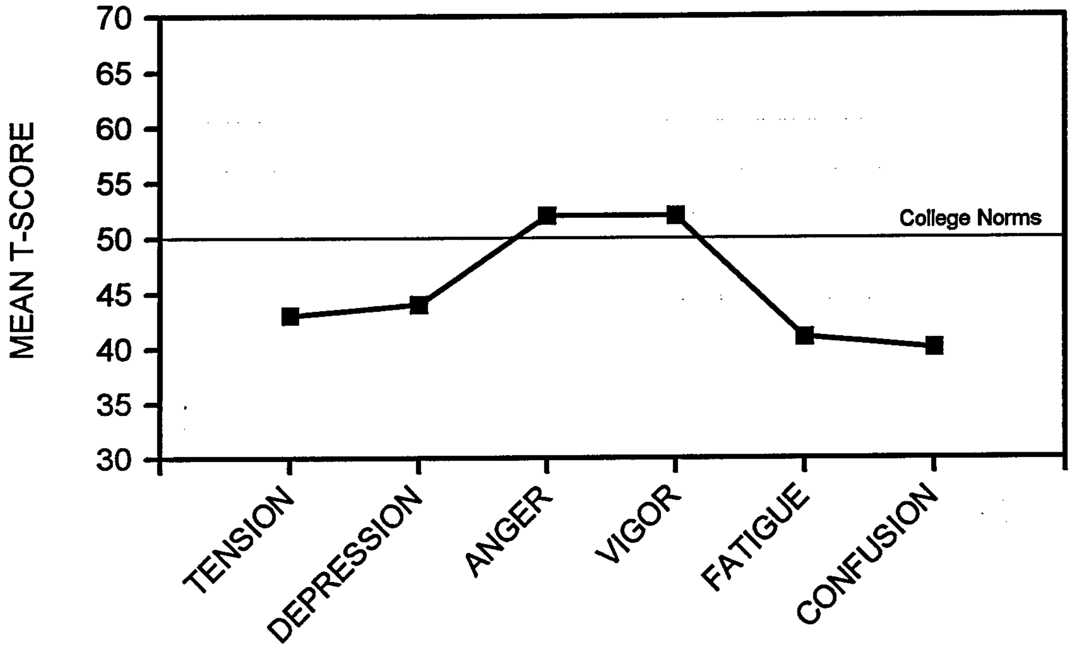
The Profile of Mood States (POMS) questionnaire (9) was used to identify subjective mood changes. The POMS is a 65-item adjective rating scale designed to assess six mood states (tension, depression, anger, vigor, fatigue, and confusion). Each adjective is scored from 0 (not at all) to 4 (extremely). The response set of "How You Have Been Feeling During The Past 24 Hours" was used.

Fifty-nine volunteers (T Ration: n=21; B Ration: n=38) participated in this part of the study. The POMS was administered 10 times: once prior to deployment at Camp Lejeune and three times each at time periods, T1, T2, and T3, while deployed (see Table 1.1 for schedule of administration). The POMS was administered at breakfast meals every other day during these three time periods. The three measures at T1, T2, and T3 were averaged to give one set of mood scores for each volunteer for each time period. Differences in mood states over time and between ration groups were assessed using repeated measures analyses of variance (ANOVAs). Changes in mood from baseline were also examined. A measure of total mood disturbance was analyzed by adding the five negative mood scales (tension, depression, anger, fatigue and confusion) and subtracting the lone positive mood scale of vigor. A constant of 100 was added to avoid negative numbers as has been done previously (10).

RESULTS

Figure 9.1 shows the mood profile prior to the field exercise. Tension, depression, fatigue, and confusion are exhibited in relatively low levels. Anger and vigor are approximately equal to normative values of college students (9).

Figure 9.1. Pre-field exercise POMS T-Scores for the various mood states.

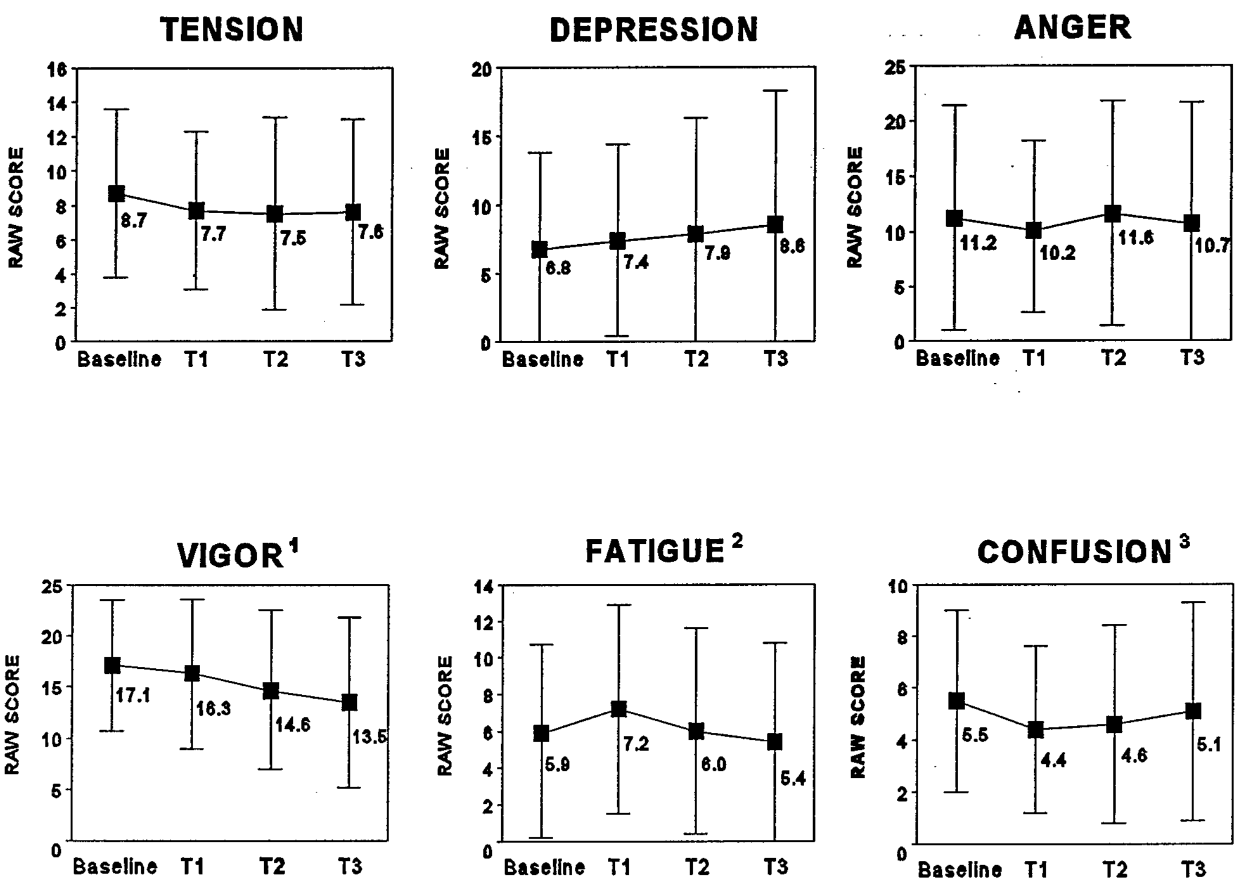


There were no differences ($p > 0.05$) either in mood or mood change scores between ration groups over the course of the study. Additionally, there were no significant ration group by time interactions for any raw mood score or mood change from baseline score. Total mood disturbance (TMD) and TMD change scores also did not exhibit any differences between ration groups or any group by time interaction effects.

Examination of moods over time (Baseline, T1, T2 and T3) showed that vigor ($p \leq 0.0001$), fatigue ($p \leq 0.002$), and confusion ($p \leq 0.05$) all showed significant mood changes from baseline, while tension, depression, anger and TMD scores did not change. Raw score means and standard deviations are shown in Figure 9.2.

Dunnett's test was used to detect differences from baseline ($p \leq 0.05$). Figure 9.3 shows means and standard deviations by ration group over time.

Figure 9.2. POMS raw scores for all Marines over time.

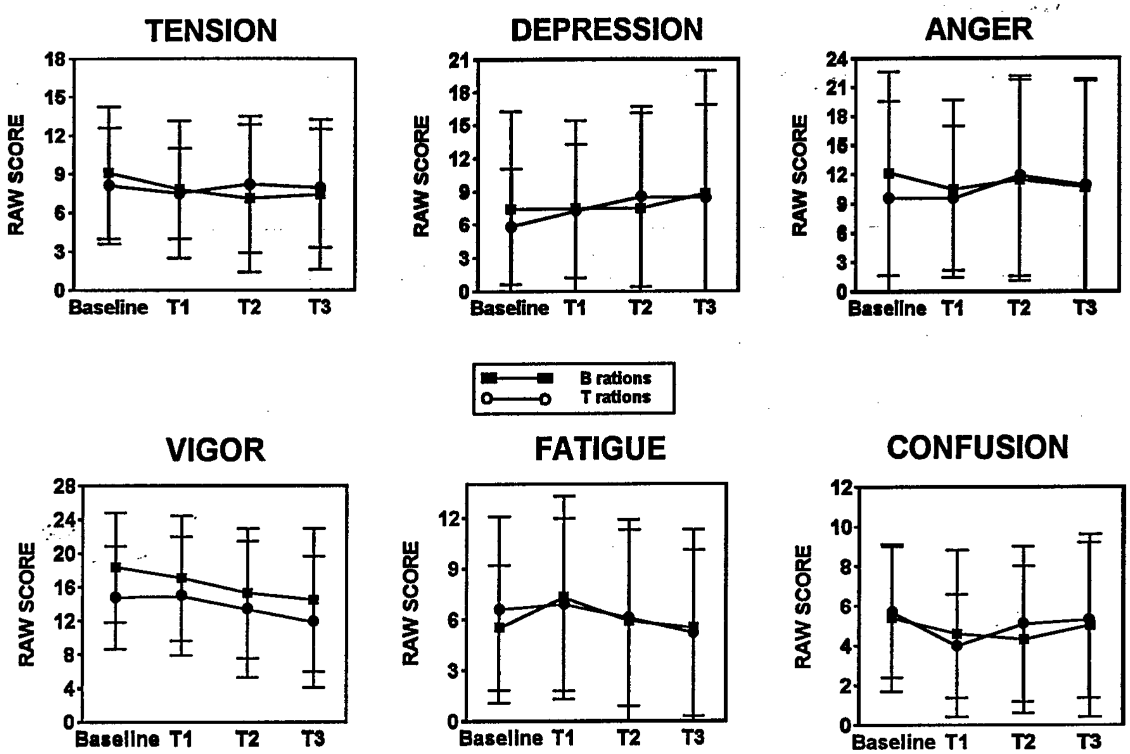


[1] Vigor at T2 and T3 were significantly ($p < 0.05$) less than Baseline.

[2] Fatigue at T1 was significantly ($p < 0.05$) greater than Baseline.

[3] Confusion at T1 and T2 were significantly ($p < 0.05$) less than Baseline.

Figure 9.3. POMS raw scores by ration group over time.



DISCUSSION

Moods did not differ significantly between ration groups. From Figure 9.3 it can be seen that between T1 (Day 5) and T2 (Day 35), four of the five negative moods (tension, depression, anger, and confusion) worsened to a greater extent for the T Ration group than the B Ration group. This is evidenced by the lines of the two groups crossing on these graphs. The small changes combined with the large standard deviations in both groups are likely responsible for the lack of significant interaction effects.

Vigor and fatigue follow somewhat similar patterns for both groups and are more likely linked to the physical worked being performed. The increase in fatigue from Baseline to T1 occurred during the heaviest work period. By T3 the work days had shortened considerably because more time was scheduled than was actually necessary to complete the task (e.g., rain days were budgeted that were not needed) and the Marines got ahead of schedule. Additionally, the heavier work (e.g., digging a foundation and pouring concrete) was replaced by lighter work (e.g., electrical wiring and cabinet work).

There are several possible explanations for the lack of significant differences between ration groups. First, as alluded to earlier, the variance within groups may have been too great to detect differences between groups. Second, the sample sizes of the T Ration group were smaller than needed to detect significant differences. *Posteri* sample size estimations (3) using an alpha of $p < 0.05$, a power level of 0.80, and the given effect sizes (i.e., differences detected in the various raw mood score values) suggests that 25-40 volunteers per ration group were necessary to detect significant differences, depending on the mood scale (tension, depression, etc). Third, it may be hypothesized that the T Ration menus were sufficiently acceptable, that they simply did not disrupt the general mood of the Marines consuming them. Although the T Ration foods were not as well-liked as the B Ration foods, as evidenced by the ration acceptability data (see Chapter 5), they did not affect the overall mood of the Marines to any great degree. Fourth, as has been stated elsewhere, the T Ration volunteers who completed the study may have been those least affected; that is, they either liked the ration or tolerated it to a reasonable extent. Had those who dropped from the study because they "could not consume the T Ration" continued to eat only T Rations, the results may have been different.

The baseline mood profile of all Marines resembles the profiles seen in two previous groups of artillery-men (7,14). These moods differ from the classic iceberg profile seen in athletes (11) and the flattened iceberg profile seen in various military populations (2,6,10). The iceberg profile is characterized by the graphic representation of T-Scores on the Y-axis and moods listed along the X-axis in the order of tension, depression, anger, vigor, fatigue, and confusion. Compared to college norms, a line connecting the plotted scores forms an "iceberg profile," with the negative moods all below college norms and the lone positive mood, vigor, above college norms. One of the reasons for differences from other military groups may be that the item "Ready to Fight" was taken to mean military readiness as opposed to hostility towards another person (7). During the instructions in this study, that item was clarified to mean hostility towards another person. Therefore, the increase in anger over other military populations or athletes may be due to the nature of the anticipated upcoming deployment or issues unique to this unit. It is also possible that "Ready to Fight" was interpreted as military readiness despite the verbal instructions to the contrary. It is important to note that the anger score is still only slightly above that seen in college students, and hence should not be considered excessive.

Vigor declined over time for all Marines. Fatigue as mentioned earlier was the highest at T1, probably due to the physical work being performed. Confusion was greatest at the Baseline and T3 time periods, which is likely a result of the unknown associated with the upcoming deployment and then the return to Camp Lejeune.

CONCLUSIONS

- Mood states were only obtained on those volunteers who completed the study. As stated in Chapter 2, there were 19 volunteers who dropped out because they could not tolerate eating the T Rations. As such, mood differences are probably not as great as they might have been had all volunteers assigned to the T Ration group eaten the T Rations for the entire 60 days.

- No significant differences in mood existed between ration groups, although four of the negative moods (tension, depression, anger, and confusion) appeared to worsen to a slightly greater extent in the T Ration group from the T1 to T2 time periods.

- Vigor decreased and fatigue increased from baseline to the T1 time period when physical work was the heaviest.

- The baseline POMS had a heightened anger score compared to the classic or flattened iceberg profiles seen in previous groups of athletes and military personnel. However, anger was still only slightly higher than college norms.

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CHAPTER 10

SUBJECTIVE COMMENTS AND OBSERVATIONS

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INTRODUCTION

The type of ration, food quality, and number of food choices can affect the acceptability of a field ration. These issues are addressed principally in Chapter 4: Dietary Adequacy and Chapter 5: Ration Acceptability. They are issues which ration developers can take into account when determining the acceptability of rations and the specific food items within the rations which need improvement. There are issues that are beyond the control of ration developers that affect ration acceptance. Often specific procedures employed in the field kitchen or serving area can be detrimental to the nutritional adequacy of the ration. Likewise, quality of taste and appeal of the food based on its presentation can also lower the acceptability of a ration if incorrect procedures are followed.

This chapter describes the subjective comments obtained from the Marine test volunteers via a questionnaire given at the end of the study, along with observations of the research team regarding the quality of the food served. The research team lived in the field and ate the same rations as the Marine volunteers during the three data collection periods (T1, T2, and T3). We also had one representative at the field site at all times between data collection periods to maintain a presence and confirm adherence to the ration assignment. This presence, along with a recipe specialist who worked with the Marine kitchen staff, gave us the access to the feeding operation which allowed us to make these subjective observations.

METHODS

The following describes the three versions of the questionnaire used to obtain subjective comments from the test volunteers.

Subjective Ration Evaluation Questionnaire

A questionnaire was given at the end of the third test period to subjectively evaluate the rations. Three versions of the questionnaire were given: one for those in the T Ration group, one for those who began in the T Ration group but ended up dropping from the study, and one for those in the B Ration group. The questions asked about weight loss and whether it was intended or not, what the Marines' opinions were of T and B Rations prior to the study, and what their opinions were of the ration (T or B) they consumed during the study.

RESULTS

Subjective Ration Evaluation Questionnaire

From the post-study assessment questionnaire, total weight loss reported by test volunteers themselves was approximately 5 kg (T Ration Group: 5.4 ± 6.4 kg; T Ration Drop Group: 4.5 ± 4.5 kg; and B Ration Group: 4.5 ± 5.4 kg), which is consistent with the weight loss recorded and reported in Chapter 3. From Table 10.1 it may be seen that of those who completed the study consuming the T Rations, 60% intended to lose weight, in contrast to the 36% who were in the group that eventually dropped from eating T Rations. A majority of the volunteers reported weight loss, but a greater proportion of those consuming T Rations reported losing weight. While most individuals were unhappy about losing weight, a substantially higher proportion of the individuals that ended up in the T Ration Drop group were unhappy about the weight loss they experienced compared to those completing the study.

Table 10.1. Subjective assessment of weight loss during the field exercise.

Question	T Ration (n = 16)		T Ration Drops (n = 11)		B Ration (n=37)	
	n	%	n	%	n	%
Did you intend to lose weight on this exercise?						
YES	9	60%	4	36%	16	43%
NO	6	40%	7	64%	21	57%
Did you lose weight on this exercise?						
YES	12	75%	10	91%	24	65%
NO	4	25%	1	9%	13	35%
Were you happy about your weight loss?						
YES	3	43%	1	17%	5	36%
NO	4	57%	5	83%	9	64%

Volunteers were asked to recall their subjective opinions of both types of rations before this exercise. Prior to this study, 33% of the volunteers had eaten T Rations. Table 10.2 shows the subjective ratings of T and B Rations by group prior to the study. While many of these individuals had never tried T Rations, all had heard of them and they were asked to rate their impressions based on the concept of the ration and/or what they had heard. Most volunteers were neutral or had a positive attitude towards T Rations prior to the study. The highest negative ratings of T Rations were by those who eventually dropped out of the study.

Table 10.2. Subjective assessment of rations prior to this study.

Question	T Ration (*n* = 16)		T Ration Drops (*n* = 11)		B Ration (*n*=37)	
	n	%	*n*	%	*n*	%
Had you eaten T Rations before						
YES	5	31%	3	27%	13	35%
NO	11	69%	8	73%	24	65%
What was your opinion of T Rations before this exercise? (9-point scale)						
Disliked 1-4 Rating	4	27%	4	40%	8	30%
Neutral 5 Rating	6	40%	6	60%	10	37%
Liked 6-9 Rating	5	33%	0	0%	9	33%
What was your opinion of B Rations before this exercise? (9-point scale)						
Disliked 1-4 Rating	0	0%	2	22%	3	9%
Neutral 5 Rating	2	18%	1	11%	6	16%
Liked 6-9 Rating	9	82%	6	66%	28	75%

In addition to these ratings, some additional comments were made *ad libitium* and are noted here:

Negative Comments*:

- "B Rations are a lot better than T Rations." *n* = 6
- "I have never eaten T Rations before but some look and smell really bad." *n*=1
- "I don't like to eat T Rations for religious reasons, B Rations give me more options (i.e., I don't eat pork products)." *n*=1
- "T Rations should be rated in the top 3 of Americans' most unliked foods." *n*=1

- "In general, T Ration foods are undeveloped, often undercooked, resulting in too much weight loss for Marines deployed to the field." *n*=1

- "T Rations are tolerable only if you eat them for a few days." *n*=1

Positive Comments or Relatively Positive Comments*:

- "T Rations were not that bad the last time I had them." *n*=2

- "T Rations are enough to sustain a Marine." *n*=1

- "Dinner meals are relatively enjoyable." *n*=1

- "I liked knowing what a T Ration menu was, which is unlike what you get with B Rations." *n*=1

- "T Rations need less preparation work." *n*=1

- "The T Ration dinner menu is not bad, but breakfast menu needs work." *n*=1

*Note: These comments were consolidated and paraphrased.

Table 10.3 summarizes what the best items were for the T Ration menu (i.e., the ration they had been eating while on the study). Some volunteers mentioned more than one item. In those cases both items were scored. Table 10.4 is a summary of items that should be served more often, while items that should be served less often are shown in Table 10.5. Only those who ate the T Ration for the entire study were surveyed on this question, since they repetitively ate T Rations for the 60 days. Table 10.6 lists T Ration items that should be dropped from the menu, while Tables 10.7 and 10.8 lists items that should be incorporated into the T Ration breakfasts and dinners, respectively. Table 10.9 lists items that were tried but volunteers but would not eat after they tasted the food. Tables 10.10 and 10.11 lists items (breakfast and dinner, respectively) volunteers got tired of because they were served too often.

Table 10.3. Best item in the T Ration menu.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Rice	6	Lasagna	3
Lasagna	4	Spice Cake	2
Chicken Breast	4	Pasta Meal	2
Vegetables	4	Rice	2
Meatballs	4	Beef Stew	2
Diced Potatoes	3	Sausage Links	2
Cake	2	Hash	1
Turkey	2	Chicken Breast	1
Beef Strips	2	Hamburgers	1
Rice and Beans	1	Turkey	1
Eggs	1	Fruit	1
Sausage	1	Vegetables	1
Spaghetti and Meatballs	1	Potatoes	1
BBQ Ribs	1	Chocolate Cake	1
Strawberry Oatmeal	1		
Western Omlet	1		
Beef Stew	1		
Chow Mein	1		

* 2 volunteers said no items, and 1 volunteer did not respond to this question in the T Ration Drop Group.

Table 10.4. Items which should be served more often in the T Ration menu.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Potatoes	3	Pasta Meal	1
Flavored Oatmeal	3	Rice	1
Chicken Breast	2	Sausage Links	1
Vegetables	2	Potatoes	1
Hamburgers	1	Flavored Oatmeal	1
Meatballs	1		
Lasagna	1		
Spaghetti	1		
BBQ Ribs	1		

* 3 volunteers said no items, and 2 volunteers did not respond to this question in the T Ration Group.
* 4 volunteers said no items, and 4 volunteers did not respond to this question in the T Ration Drop Group.

Table 10.5. Items which should be served less often in the T Ration Menu.

T Ration Group	
T Ration Foods	**Times Mentioned**
Chicken Breast	5
Turkey	3
Corn Beef Hash	3
Hamburgers	3
Ham Slices	2
Spaghetti	1
Eggs	1
Crumb Cake	1

* 1 volunteer said no items, and 4 volunteers did not respond to this question.

Table 10.6. Items which should be dropped from the T Ration menu.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Eggs	3	Eggs	2
Hamburgers	3	Hamburgers	2
Ham Slices	2	All Current Breakfast Meals	2
Apple Dessert	2	Chicken Chow Mein	1
Spaghetti	1	Hash	1
Turkey	1	Potatoes	1
Stir Fry	1	Rice and Beans	1
Oriental Rice	1		
Eggs and Sausage	1		
Pork	1		
Hash	1		
All Current Breakfast Meals	1		
Diced Potatoes	1		
Lasagna	1		
Chocolate Cake	1		

* 1 volunteer said all items, and 1 volunteer said no items in the T Ration Group.

* 2 volunteers said all items in the T Ration Drop Group.

Table 10.7. Suggested additions to the T Ration breakfast menu.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Waffles	6	Pancakes	2
Hash Browns	5	Biscuits	2
Pancakes	5	Creamed Beef on Biscuit	1
Cold Cereal	5	Muffins	1
Biscuits and Gravy	4	Hash Browns	1
Bacon	4	Bacon	1
Grits	4	French Toast	1
Flavored Oatmeal	4	Salsa	1
Fruit	1	Improved Eggs	1
Other Juices	1	Ham	1
Blueberry Muffins	1	Flavored Oatmeal	1
French Toast	1	Waffles	1
Breakfast Burritos	1		
Plain Eggs	1		
Creamed Beef on Biscuit	1		

* 1 volunteer said no items, and 1 volunteer did not respond to this question in the T Ration Group.

* 1 volunteer said no items in the T Ration Drop Group.

Table 10.8. Suggested additions to the T Ration dinner menu.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Pizza	5	Pizza	2
Steak/Red Meat	4	More Different Pasta	1
Pork Chops	3	Dinner Rolls	1
Chili	3	Pork Chops	1
BBQ Burgers	3	Beef Stew	1
BBQ Chicken	3	Steak	1
More Vegetables	2	Chicken and Rice	1
Grilled Cheese	2	Asparagus	1
Soups/Cup of Noodles	2	Pizza Pockets	1
Fish	2	Chili con Carne	1
Different Potatoes	1	Chili Macaroni	1
Veal	1	Beef Stroganoff	1
More Salad	1		
Chicken and Rice	1		
Chicken Parmesan	1		
Breaded Chicken	1		
Mexican Food	1		
More Fruit	1		
Canned Fruit	1		
Macaroni	1		
Chowder	1		
Canned Tuna	1		
Mashed Potatoes and Gravy	1		

* 2 volunteers did not respond to this question in the T Ration Group.

Table 10.9. Items in the T Ration menu that were tried but would not eat again.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Hash	9	Eggs In General	6
All Breakfast Items	4	Hamburgers	4
Turkey	3	Ham Slices	4
Chicken Breast	3	Lasagna	3
Beef Strips	3	BBQ Ribs	3
Ham Slices	2	Chicken Breast	3
Chocolate Cake	2	Pork Chow Mein	2
BBQ Ribs	1	Apple Dessert	2
Spaghetti	1	All Breakfast Items	2
Eggs With Bacon	1	Corn Beef Hash	2
Green Beans	1	Spaghetti	2
Lasagna	1	Turkey	2
Chicken Stir Fry	1	Juice	2
Potatoes	1	Rice	2
Hamburgers	1	Eggs With Sausage	2
Eggs in General	1		
Meatballs	1		

Table 10.10. T Ration items Marines tired of at breakfast.

T Ration Group		T Ration Drop Group	
T Ration Foods	**Times Mentioned**	**T Ration Foods**	**Times Mentioned**
Eggs in General	6	Eggs in General	3
Hash	5	Cake	2
Sausage	3	Sausage	2
Cake	2	Eggs and Sausage	1
Ham	2	Oatmeal	1
Apple Dessert	2	Ham	1
Breakfast Items in General	2		
Oatmeal	1		

* 1 Volunteers said no items in the T Ration Group.

Table 10.11. T Ration items Marines tired of at dinner.

T Ration Group		T Ration Drop Group	
T Ration Foods	Times Mentioned	T Ration Foods	Times Mentioned
Spaghetti	4	Lasagna	3
Rice	3	Chicken	2
Hamburgers	2	Cake	1
Cake	2	BBQ Ribs	1
Turkey	2	Chicken Chow Mein	1
Chow Mein	2	Rice	1
Chicken Breast	2	Spaghetti	1
Meat Balls	2		
BBQ Ribs	2		
Beef Slices With Peppers	1		
Beef Stew	1		
Green Beans	1		
Carrots	1		
Chicken Stir-Fry	1		
Potatoes	1		
Lasagna	1		

* 4 volunteers did not respond to this question in the T Ration Group.
* 1 volunteer said all items in the T Ration Drop Group.

Tables 10.12 to 10.20 summarize comments from volunteers in the B Ration group (i.e., the ration they had been eating while on the study). Some volunteers mentioned more than one item. In those cases both items were scored.

Table 10.12. Best item in the B Ration Menu.

B Ration Group	
B Ration Foods	**Times Mentioned**
Pork Chops	25
Chicken and Rice	21
Shrimp Creole	12
Beef Cube	8
Chicken Creole	5
Beef Patties	5
Beef Stew	5
Chili Macaroni	5
Mashed Potatoes	3
Fruit	2
Milk	2
Pancakes	2
Cherry Crisp	2
Creamed Beef	2
Eggs and Cheese	2
Cookies	2
Ham-Tomato Macaroni	1
Bacon	1
Chili con Carne	1
Peas and Carrots	1
Potatoes	1
Spam	1
Beef and Gravy	1
Corn	1
Dessert in General	1

* 1 volunteer said no preference.

Table 10.13. Items which should be served more often in the B Ration menu.

B Ration Group	
B Ration Foods	**Times Mentioned**
Pork Chops	12
Chicken and Rice	10
Beef Cubes	6
All Fruit	5
Beef Stew	4
Biscuits	3
Beef Patties	3
Grits	2
Creamed Beef	2
Pancakes	2
Beef Gravy	1
Cinnamon Rolls	1
Salad	1
Sausage	1
Mashed Potatoes	1
High Protein Foods	1
Cookies	1
Apple Sauce	1

Table 10.14. Items which should be served less often in the B Ration Menu.

B Ration Group	
B Ration Foods	**Times Mentioned**
Shrimp Creole	15
Beef Hash	10
Ham-Tomato Macaroni	9
Beef Cubes in Gravy	8
Spam	6
Chili Macaroni	5
Chicken Creole	4
Eggs	4
Pork Chops	4
Chili con Carne	4
Packaged Juice	4
Biscuits	4
Bacon	4
Potatoes	4

* 1 volunteer said no items, 1 volunteer said all items, 1 volunteer said all items except pork chops, and 2 volunteers did not respond to this question.

Table 10.15. Items which should be dropped from the B Ration menu.

B Ration Group	
B Ration Foods	**Times Mentioned**
Spam	5
Beef Hash	3
Ham-Tomato Macaroni	3
Saccharin Juice	2
Bread	1
Peas and Carrots	1
Chicken and Rice	1

* 1 volunteer said no items, and 10 volunteers did not respond to this question.

Table 10.16. Suggested additions to the B Ration breakfast menu.

T Ration Group	
B Ration Foods	**Times Mentioned**
Pancakes	14
Cold Cereal	9
Sausage	8
French Toast	8
More Fruit	6
Waffles	6
Flavored Oatmeal	4
Ham Slices	3
Toast	2
Western Omelet	2
Real Eggs	2
Fried Rice	1
Variety of Meat	1
Pop Tarts	1
Skim Milk	1
Bagels	1
Cinnamon Honey Rolls	1
Corn Beef Hash	1
Cheese Grits	1

* 1 volunteer said no items, and 4 volunteers did not respond to this question.

Table 10.17. Suggested additions to the B Ration dinner menu.

B Ration Group	
B Ration Foods	**Times Mentioned**
Steak/Beef Items	7
Hamburgers/Cheeseburgers	7
Hamburger Helper	4
Spaghetti	3
Lasagna	3
More Fruit	3
Pizza	2
Mexican Food	2
More Variety of Vegetables	2
More Pasta	2
Real Ham	2
Ribs	2
Roast Pork Slices	1
Fried Chicken	1
Red Beans and Rice	1
Different Fruit Drinks	1
Pork and Beans	1
Black Eyed Beans	1
Pinto Beans	1
Egg Noodles	1
Hot Dogs	1
Ravioli	1
Skim Milk	1
Grilled Cheese	1
Soup	1
Seafood	1
BBQ Chicken	1
Rolls	1
Chicken Breast	1
French Fries	1
Fried Rice	1

* 2 volunteers said no items, and 11 volunteers did not respond to this question.

Table 10.18. Items in the B Ration menu that were tried but would not eat again.

B Ration Group	
B Ration Foods	**Times Mentioned**
Beef Hash	9
Spam	8
Shrimp Creole	8
Ham-Tomato Macaroni	7
Eggs	4
Chicken Creole	3
Chili Macaroni	1
Fruit Drinks	1
Creamed Beef on a Biscuit	1
Beef Cube	1
Biscuits	1
Potatoes	1

* 9 volunteers did not respond to this question.

Table 10.19. B Ration items Marines tired of at breakfast.

B Ration Group	
B Ration Foods	**Times Mentioned**
Eggs in General	20
Potatoes	13
Spam	6
Biscuits	5
Beef Hash	5
Bacon	2
Pork Products	1
Creamed Beef on a Biscuit	1
Fruit Drinks	1
Grits	1

*6 volunteers did not respond to this question.

Table 10.20. B Ration items Marines tired of at dinner.

B Ration Group	
B Ration Foods	**Times Mentioned**
Shrimp Creole	6
Pork Chops	5
Chicken Creole	4
Chili Macaroni	3
Ham-Tomato Macaroni	3
Beef Gravy	2
Peas	1

*1 volunteer said no items, 1 volunteer said everything, and 14 volunteers did not respond to this question.

The suggested length of the menu cycle for all 3 groups (T Ration, T Ration Drops, and B Ration) for both rations was reported to be between 13 and 14 days. The mean rating of the T Rations by those who completed the study were: before study, 4.0 ± 3.2, and after study, 4.0 ± 4.0. The mean rating of the T Rations of those who did not complete the study were: before study, 3.8 ± 2.2, and after study, 2.0 ± 1.0. These scores are out of a scale from 1-9, with 1= extremely dislike, 5 = neither like nor dislike and 9 = like extremely. For B Rations the mean rating of those consuming B Rations was 6.4 ± 3.0 before the study, while after the study the rating was 7.0 ± 4.0. In response to asking about the favorability of T Rations, the following *ad libitium* comments were offered:

Negative Comments*:

- Strong negative comments about T Rations; e.g., "hate the taste of T Rats," and "it tastes like dog food." *n*=7
- "Food has negative after-tastes and causes burping." *n*=3
- "Breakfast is horrible." *n* = 2
- "Would eat T Rations to survive, but do not like it." *n*=2
- "T Rations need more work in development." *n*=2
- "I would not want to eat T Rations for long periods of time, like 3 months." *n*=1
- "T Rations are only fuel for the body, they are not food that you can enjoy." *n*=1
- "T Rations look like pre-fabricated food." *n*=1
- "Everything except for the chocolate and vanilla cakes are horrible." *n*=1
- "T Rations shouldn't be used any more, stay with B Rations." *n*=2

- "Too many meat products in T Rations."
- "Menu cycle is too short."
- "Need better grade of beef and better juice drinks."

Positive or Relatively Positive Comments*:

- "If there were more items for breakfast they would be O.K." *n*=2
- "Vegetables in T Rations are better than those in B Rations." *n*=1
- "T Rations are good overall, but the breakfast menu needs more choices." *n*=1
- "Meals have potential but the kitchen staff preparing them need more guidance." *n*=1
- "Food is not that bad, but I expected better." *n*=1

*Note: These comments were consolidated and paraphrased.

When Marines were asked if they could brief the Commandant of the Marines as to what the feeding policy should be for B and T Rations, the following comments* were offered:

- "Stick with using only B Rations, troop morale will be hurt otherwise." *n* = 21
- "T Rations need to have more choices, but the idea is good and should be used if you can overcome the shortcomings; that is, they need to ensure they are supplemented with fresh fruits and salads, have a greater variety of vegetables for dinner and cereals for breakfast." *n* = 13

- "T Rations need more work, as the current version is not acceptable or beneficial for troop welfare." n=10

- "I would go with the T Rations, but not before improving the breakfast." $n = 5$

- "I would use a combination of B and T Rations, but would not use T Rations in their current form." $n = 4$

- "Need different types of meals for different geographical areas. T Rations are appropriate in many situations." $n = 2$

- "Recommend not using T Rations for more than 3 months at a time." n=2

- "Suggest bigger portion sizes to combat weight loss." n=1

- "Preparation of the food is ideal, but it is not edible." n =1

*Note: These comments were consolidated and paraphrased.

OBSERVATIONS AND DISCUSSION

During the Gulf War many problems plagued the quality of the rations that had little to do with the makeup of the ration itself. Distribution of the rations was difficult, with many units receiving only one or two meals, or not receiving all of the components of a particular meal. The heat generated within the kitchen area from the stoves combined with the desert heat took their toll on those preparing rations. Refrigerators were often unavailable. The appearance of flies was correlated with warm temperatures and minimized the serving of certain ration components because the food could not be protected. Blowing fine-grain sand was impossible to keep out of the food during preparation and serving (1). While specific doctrine may provide for acceptable rations, in reality these procedures are often difficult to follow. Admittedly, the conditions encountered on this study were not as difficult as those cited during the Gulf

War; nonetheless they affected the quality of the meals served and impacted the nutritional status of the troops.

Analyses of questionnaire data indicate that the Marines in general felt that they preferred B Rations in comparison to T Rations. There was some pre-deployment bias toward the B Rations, especially among those individuals who eventually dropped from the study as indicated in Table 10.2. When the Marines were asked for their opinions on helping to develop a policy toward using T Rations, the number one response from open-ended questioning was that use of T Rations will hurt troop morale and the Marines should continue the use of B Rations. If T Rations are to be used, the quality and variety need to be improved. T Rations need to be supplemented with fresh fruits and vegetables, along with the provision of breakfast cereals. If the T Ration could be served the way it was designed (i.e., with all menus available and with supplements), it may have been better received. How the T Ration was served during this study shows realistically how the T Ration would be served. Because of the lack of preparation facilities, there would be little the kitchen staff could do to enhance the menu they receive. Under conditions similar to this study or as those described above in the Gulf War, if Marines had a choice, they would opt for B Rations.

The following are specific observations and opinions of the research staff regarding the food preparation and service. We feel that these issues impact ration quality and acceptability, which ultimately lead to the nutritional adequacy of soldiers and Marines deployed for extended periods of time in field training or combat scenarios.

- Unfortunately, the entire T Ration menu was not tested. The two breakfast menus containing creamed ground beef were not shipped and were replaced by eggs with bacon and cheese. This further increased the surfeit of eggs in the breakfast menus. Most of the boxes labeled "Western Style Scrambled Eggs" actually contained "Scrambled Eggs With Bacon and Cheese." The "Plain Scrambled Eggs" were replaced with "Eggs and Sausage." New T Ration items that were not tested on this field study may greatly improve the breakfast selections. These new items include waffles, biscuits, and pancakes which were among items frequently requested.

- With regard to B Rations, items such as pancakes, french toast and hamburgers were actually on the menu, but because their was limited griddle space, these items could not be efficiently prepared for the entire unit. Therefore, they were not served, but they were among the most frequently cited items that should be added to the B Ration menu from the post-study questionnaire.

- The presentation of the T Ration breakfast eggs was unappealing until a study team member suggested to the mess staff to "fluff up" the eggs before serving. The staff was cutting the eggs out in squares and serving them the way lasagna would be served. Presentation of the food often is as important as the taste itself, and education of the mess staff in this area may enhance T Ration acceptability.

- The instant juices that came with the T Ration breakfast menus were rarely served because of the additional time and inconvenience involved. Instead, the artificially sweetened beverage base from the B Ration menus was provided. The kitchen staff seemed unaware and unconcerned about the nutritional merits and superior taste of a real juice beverage.

- Approximately half-way through the exercise, the unit ran out of bulk sugar. If additional sugar had been procured, consumption of non-sugared beverages could have been enhanced for some Marines.

- Provision of condiments other than hot sauce may enhance the acceptability of some of the T Ration items. For example, ketchup could have improved the taste of the hamburger patty.

- The breakfast menu would have been greatly enhanced if cold cereals and additional packets of flavored oatmeal had been provided. Although shelf-stable bread was provided, the boxes sent by Defense Supply Center Philadelphia (DSCP) were more than a year out-of-date and, as a result, noticeably degraded in taste and texture. Fresh fruit and salad were only sporadically available. Even when salad was available, salad dressing was not provided because of the expense of local procurement.

- Approximately 2 weeks into the exercise, the ice machine broke, making ice unavailable for cooling beverages or keeping salads fresh. Therefore, beverages were served warm, reducing their appeal. Salad should have been kept in the refrigerator until meal service and would not have seriously deteriorated during the one hour of meal service. The unit could also have taken advantage of ice available from the nearby Coast Guard Station but did not.

- By the third phase of data collection, the kitchen staff seemed fatigued and dispirited. This was likely attributable to extended work days and absence of a complete day off (unlike most members of the unit). In addition, the cooks seemed to receive little appreciation for their efforts, which could negatively affect their ability to provide consistent, high-quality meals throughout a long deployment.

CONCLUSIONS

- Comments from the Marines revealed they would prefer that B Rations remain as their go-to-war ration. If T Rations are to be used, they should be supplemented and improved.

- The observations of the research staff revealed that there were certain on-site "fixes" to help improve acceptability of all rations and the T Ration in particular.

    - Attention to presenting the food in an appealing manner and in ways that Marines or soldiers would find familiar is likely to enhance acceptability of the food.

    - While the T Ration menu is more limited than A or B Rations, it is important to try and provide as much variety as possible with the T Rations. This would include having such items as waffles, pancakes, and hot and cold cereals for breakfast.

- Supplementing the T Ration meals with salad and fresh fruits is likely to improve the acceptance of the entree.

- Food that is best served hot, such as the entrees, should be served hot, and food such as fruit drinks and juices should be served cold.

- If possible, choices in condiments should be greater, especially since menu choices decrease with T Rations compared to B Rations.

- Ensuring that the mess staff does not experience fatigue is important to the whole unit. Since quality of meals are likely to affect unit morale, the mess staff should not be fatigued or carrying an unfair burden of the work compared to the rest of the unit. Enthusiasm by the mess staff will likely produce higher quality meals resulting in improved overall morale of the unit. While this point is important for the serving of T Rations, it is probably even more important for B Rations, where there is even greater preparation and variability in the quality of the food preparation.

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CHAPTER 11

CONCLUSIONS AND RECOMMENDATIONS

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DISCUSSION

The objective of this study was to test the effectiveness of using the Tray Pack Ration (T Ration) for an extended duration by the U.S. Marine Corps (USMC). The USMC in a tasking letter (1) requested that information be obtained to allow the Office of the Army Surgeon General (OTSG) to develop a T Ration feeding policy. Specifically, the information needed would address the nutritional adequacy of T Ration consumption for extended periods of time. While the nutrient intake of the rations themselves may meet the Military Recommended Dietary Allowances (MRDAs), it was necessary to determine if soldiers or Marines actually consume the recommended amounts and the right mix of the rations to meet their nutritional needs. Additionally, to determine if the ration was adequate, an assessment of weight loss was necessary. Previous research (2) has led to a policy of a 21-day limit on continuous feeding of Meals, Ready-to-Eat (MREs) based on the prevalence of a 3% weight loss after 21 days of continuous MRE consumption. Associated with weight loss, an examination of energy intake and energy expenditure levels are necessary to quantify the work levels of Marines or soldiers, and the likelihood of particular field rations for meeting these energy requirements. The results of this study examined all of these parameters. Weekly body weights were measured to determine the extent and rate of weight loss. Energy balance was obtained by assessing energy expenditure and energy intake of a sub-sample of Marines who were administered stable water isotopes. A questionnaire detailing weekly physical symptoms, assessments of body composition, measurements of the amount and quality of sleep, and three measures of physical strength and power aided in determining the effects of 60 days of T Ration consumption on health and performance. Measures of ration satisfaction and how that related to troop morale were ascertained by obtaining subjective ratings of rations, overall questions concerning the Marines' own recommendations on T Ration use, and an examination of mood states over time.

Our research showed that consumption of T Rations for up to 60 days by Marine construction engineers and other administration and support personnel participating in a construction mission on Great Inagua, Bahama Islands, did not produce any greater weight losses or physical symptoms than the consumption of B Rations. B Rations are the ration the USMC is currently using during field deployment exercises. Weight loss exceeded 3% in both groups by Day 56 of the study. This average rate of weight loss is low and generally regarded as tolerable. Overall, consumption of T Ration foods was lower leading to lower intake levels of energy and various macro- and micronutrients. Average energy intake for those in the T Ration group was 2572 kcal/day vs. 2866 kcal/day for those in the B Ration group. Macronutrient intake distributions between the two ration groups were similar (T Ration: CHO=48.5%, PRO=15.4%, FAT=35.6%, ALCO=0.5% vs. B Ration: CHO=49.7%, PRO=14.3%, FAT=35.2%, ALCO=0.7%)[1]. Total daily energy expenditure averaged 3328 kcal/day for all Marines, while TDEEs were higher for the construction engineers (3460 kcal/day) compared to administration and support personnel (3109 kcal/day) due to the more physical nature of their jobs. Physical performance as measured by repeated bench press and arm curl lifting and vertical jump performance was not affected by the type of ration consumed. Volunteers slept an average of 6.5 hrs per night with no differences between ration groups. The construction mission itself, building two buildings for the Bahamian Royal Defence Force (RBDF), was not affected by ration consumption or the study itself as the project was completed on time and without incident.

The diets of both ration groups met most of the MRDA nutrient levels. The T Ration intake remained relatively consistent throughout the 60 days. However, both

[1]CHO = carbohydrate, PRO = protein, FAT = fat, ALCO = alcohol

intake and ratings of T Rations were lower than those of B Rations during the first week of the deployment. B Ration quality declined over time as kitchen personnel became fatigued and ingredients were depleted. As the quality of B Rations declined, food intake of those assigned to the B Ration group shifted to more "pogey bait" foods.

T Rations were not well received by the Marine test volunteers in this study. There was a 44% (19 of 43) drop rate from the study due to the decision of volunteers not to eat T Rations for the 60 days of the study. All of these drops were of the rank E-4 or below. No volunteers from the B Ration group dropped from the study because of the food. Mood changes worsened to a slightly greater extent in the T Ration group over time compared to those in the B Ration group. Furthermore, when asked about the quality of the rations, the T Ration breakfast entrees were rated extremely poor. By the third test period not one entree received a score of 5.0 or greater ("neither like nor dislike"). T Ration dinner items in general were initially rated as acceptable, but repeated servings of limited items later produced ratings that were deemed unacceptable. When volunteers were asked if they could brief the Commandant of the Marines on what the feeding policy should be for B and T Rations, the number one comment voiced by 31% (21 of 68) of the volunteers responding was "Stick with B Rations, troop morale will be hurt otherwise."

RECOMMENDATIONS

- Trained food service personnel should be available even when T Rations are used to ensure proper menu selection, storage of food, that contamination or infestation of kitchen and serving area of insects and/or rodents does not take place, and that the food has been heated sufficiently before serving.

- The importance of providing supplemental salads, fresh fruits and vegetables as standard doctrine indicates should be emphasized.

- Providing alternatives to T Ration eggs in the morning, such as cold and hot cereals, provides for more variety and may increase energy intake. Various types of eggs were served as the entree 7 days a week for 60 days.

- Neither T nor B Rations fed exclusively for long periods of time appear to be advantageous. Weight loss, while not overly excessive, began to accelerate in the second month for both ration groups. Some individuals began to rely increasingly on outside food sources as time proceeded. As has been recommended previously, a switch to A Rations as soon as logistically possible should be made.

- Foods need to be presented and served in appealing and familiar ways, which will likely increase the acceptability of the ration.

- Choices in condiments should be made available.

REFERENCES

1. Commandant of the Marine Corps. T Rations (Tray Packs). Tasking Letter from the U.S. Marine Corps. November 16, 1997.

2. Thomas, C.D., K.E. Friedl, M.Z. Mays, S.H. Mutter, R.J. Moore, D.A. Jezior, et. al., Nutrient intakes and nutritional status of soldiers consuming the Meal, Ready-to-Eat (MRE XII) during a 30-day field training exercise. USARIEM Technical Report T95-6, Natick, MA, 1995.

APPENDIX

MENUS SERVED DURING THE STUDY

Saturday 4 April

BREAKFAST

B Ration

Scrambled Eggs
Grilled Luncheon Meat (Spam)
Hashed Brown Potatoes
Biscuit
Orange Juice, canned

T Ration

Scrambled Eggs w/ Bacon and Cheese
Sausage Links
Spice Cake
NO PEARS *(Not packed in box.)*
Grape Juice

Common Items
Fresh Apples and Oranges
Peanut Butter
Apple and Grape Jelly
Pouch Bread
Milk, UHT[1], White and Chocolate, whole
Grape Juice (from concentrate, T item)

DINNER

B Ration

Chicken and Rice
Corn
Sliced Peaches
Brownie, Chocolate Frosted

T Ration

Meatballs and Gravy
Rice
Green Beans
Chocolate Cake

Common Items
Salad with Tomatoes and Carrots
Fresh Apples and Oranges
Peanut Butter
Apple and Grape Jelly
Pouch Bread
Milk, White and Chocolate, whole
Grape juice (from concentrate)

[1] All milk provided was aseptically packaged, Ultra-High Temperature (UHT) processed milk.

Sunday, 5 April (Liberty)

BREAKFAST

B Ration

Roast Beef Hash
Scrambled Eggs
Hashed Brown Potatoes
Biscuit

T Ration

Corned Beef Hash
Pork Sausage Link
Coffee Cake w/ Cinnamon Crumbs
Instant Oatmeal

Common Items

Fresh Apples and Oranges
Peanut Butter
Apple and Grape Jelly
Pouch Bread
Milk, White and Chocolate, whole
Grape Juice, bulk
Orange Juice, bulk and canned
Apple Juice, canned

DINNER

B Ration

Beef and Gravy
Mashed Potatoes
Peas
Oatmeal Cookies

T Ration

Chicken Breast in Gravy
Potatoes in Butter Sauce[2]
Corn
Chocolate Cake

Common Items

Salad w/ Tomatoes and Carrots
Pouch Bread
Peanut Butter
Jelly
Orange Drink, Sugar-Free

[2] In place of glazed sweet potatoes.

6 April, Monday

Breakfast

B Ration

Creamed Ground Beef
Hashed Brown Potatoes
Scrambled Eggs
Grits not served; Ran out of utensils to make them.

T Ration

Omelet w/ Bacon and Cheese[3]
Ham Slices
Fruit Cocktail
Instant Oatmeal

Common Items

Fresh Apples and Oranges
Peanut Butter
Apple and Grape Jelly
Pouch Bread
Milk, White and Chocolate, whole
Orange Juice, bulk

Dinner[4]

B Ration

Shrimp Creole
White Rice
Carrots
Corn Bread
Sugar Cookies
Peaches not served, left in reefer by mistake

T Ration

Beef Strips w/ Peppers
Oriental Rice
Carrots
Chocolate Cake

Common Items

Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly
Fruit Drink, artificially sweetened

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[3] Supposed to be Western Omelet according to label on box.
[4] Ice machine broke. Will take several weeks to repair.

7 April, Tuesday

BREAKFAST

B Ration

Scrambled Eggs
Bacon
Hashed Brown Potatoes
Grits
Biscuits

T Ration

Omelet w/ Sausage
Ham Slice
Apple Dessert
Yellow Cake w/ Chocolate Crumbs
Oatmeal, Regular

Common Items
Pouch Bread
Peanut Butter
Jelly
Bananas, Oranges, Apples
Milk, White, whole
Orange Juice, canned

DINNER

B Ration

Chili Macaroni
Cornbread (not sweet)
Green Beans
Peaches
Cherry Crisp

T Ration

Boneless Pork Rib w/ BBQ Sauce
Red Beans and Rice w/ Bacon
Applesauce
Devil's Fudge Cake w/ Coconut Topping

Common Items
Oranges
Pouch Bread
Grape Drink and Orange Drink, sugar-free
Peanut Butter
Apple Jelly

8 April, Wednesday

Breakfast

B Ration

Grilled Spam
Scrambled Eggs
Hashed Brown Potatoes
Cinnamon Rolls

T Ration

Corned Beef Hash
Coffee Cake w/ Cinnamon Crumbs
Apple Dessert
Instant Oatmeal

Common Items
Bananas, and Oranges
Milk, White, whole
Pouch Bread
Peanut Butter
Jelly
Canned Orange Juice and Apple Juice

Dinner

B Ration

Beef Patties
Gravy w/ Vegetables
Mashed Potatoes
Corn
Fruit Cocktail

T Ration

Chicken Chow Mein
Oriental Rice
Green Beans
Devil's Fudge Cake w/ Coconut Topping

Common Items
Oranges and Apples
Grape sugar-free Beverage
Cherry sugar-free Beverage
Pouch Bread
Peanut Butter
Jelly

9 April, Thursday

Breakfast

B Ration

Beef Hash
Scrambled Eggs
Biscuits

T Ration

Omelet w/ Sausage
Pork Sausage Links
Spice Cake
Pears

Common Items

Oranges
Grape Juice
Canned Orange Juice and Apple Juice
Pouch Bread
Jellies
Peanut Butter

Dinner

B Ration

Creole Chicken
Rice, white w/ Margarine
Green Beans
Biscuits
Sweet Cornbread
Canned Peaches

T Ration

Spaghetti and Meatballs
Corn
Coffee Cake

Common Items

Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly
Fruit Drink, artificially sweetened

2 May, Saturday (Liberty)

Breakfast

B Ration

Beef Hash
Scrambled Eggs
Grits
Biscuits

T Ration

Corned Beef Hash
Pork Sausage Link
Coffee Cake

Common Items
Oranges
Pouch Bread
Jelly
Peanut Butter
Milk, White and Chocolate, whole
Fruit Drink, artificially sweetened

Dinner

B Ration

Chicken Creole
Peas and Carrots
Sweet Cornbread
Rice, white

T Ration

Spaghetti and Meatballs
Corn
Coffee Cake w/ Crumb Topping

Common Items
Oranges
Lemonade, artificially sweetened w/ added Sugar
Cherry Beverage, artificially sweetened w/ added Sugar
Pouch Bread
Peanut Butter
Jelly

3 May, Sunday (Liberty)

Breakfast

All Common Items

Pancakes and Syrup
Scrambled Eggs
Creamed Ground Beef
Biscuit
Bacon
Pork Sausage Links
Apple Pie Filling
Cherry Pie Filling
Orange Juice, canned
Milk, White and Chocolate, whole
Fruit, Drink, artificially sweetened w/ added Sugar
Pouch Bread
Jelly
Peanut Butter

Dinner

B Ration

Chili Con Carne
Rice, white
Corn (w/o Margarine)
Biscuits
Yellow cake w/ Chocolate icing

T Ration

Turkey Slices
Diced potatoes in Butter Sauce
Peas
Coffee cake w/ Cinnamon Crumbs

Fruit drink, artificially sweetened w/ added Sugar
Milk, White and Chocolate, whole
Oranges
Pouch bread
Peanut butter
Jelly

4 May, Monday

Breakfast

B Ration

Scrambled Eggs
Luncheon Meat
Hashed Potatoes
Biscuit

T Ration

Omelet w/ Sausage
Pork Sausage Links
Pear Halves
Spice Cake

Common Items

Grape Juice
Cherry Beverage, artificially sweetened w/ added Sugar
Milk, White and Chocolate, whole
Oranges
Pouch Bread
Peanut Butter
Jelly

Dinner

B Ration

Beef Stew
Mashed Potatoes
Green Beans
Oatmeal Cookies

T Ration

Beef Stew
Rice
Peas
Yellow Cake w/ Chocolate crumb

Common Items

Fruit Drink, artificially sweetened w/ added Sugar
Milk, White and Chocolate, whole
Oranges
Pouch Bread
Peanut Butter
Jelly

5 May, Tuesday

Breakfast

B Ration

Scrambled Eggs
Bacon
Hashed Brown Potatoes
Biscuit

T Ration

Corned Beef Hash
Apple Dessert
Coffee Cake

Common Items
Orange Juice
Cherry Fruit Drink w/ added Sugar
Oatmeal, Instant
Pouch Bread
Jelly
Peanut Butter

Dinner

B Ration

Shrimp Creole
Rice, white
Peas
Peanut Butter Cookies

T Ration

Lasagna
Green Beans
Spice Cake

Common Items
Fruit drink w/ added Sugar
Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly

6 May, Wednesday

Breakfast

B Ration

Scrambled Eggs
Creamed Ground Beef
Hashed Brown Potatoes
Biscuit

T Ration

Omelet w/ Cheese and Bacon
Sausage Links
Spice Cake

Common Items
Grape Juice
Fruit Drink, artificially sweetened
Apple and Orange Juice, canned
Oatmeal
Pouch Bread
Peanut Butter
Jelly
no fresh fruit

Dinner

B Ration

Chicken and Rice
Carrots
Cherry Crisp

T Ration

Hamburgers
Buns
Beans and Bacon
Fruit Cocktail

Common Items
Fruit Drink, artificially sweetened
Catsup
Mustard
Cheese Spread
Pouch Bread
Peanut Butter

7 May, Thursday

Breakfast

B Ration

Scrambled Eggs w/ Shortening
Beef Hash
Grits w/ Margarine
Biscuit

T Ration

Omelet w/ Sausage
Ham Slices
Apple Dessert

Common Items

Orange Juice, from concentrate (T Ration Item)
Apple Juice, canned
Fruit Drink, artificially sweetened
Milk, White and Chocolate, whole
Oatmeal, regular (B Ration item)
Pouch Bread
Jelly
Peanut Butter
Oranges

Dinner

B Ration

Ham-Tomato Macaroni
Corn w/o Margarine
Biscuits w/ Margarine
Brownies, no icing

T Ration

Meatballs and Gravy
Rice, white
Green Beans
Chocolate Cake w/ Vanilla Crumb Topping

Common Items

Fruit Drink, artificially sweetened w/ Sugar added
Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly

23 May, Saturday

Breakfast

B Ration

Beef Hash
Scrambled Eggs w/ Shortening
Grits w/ Margarine
Biscuit w/ Margarine
Fruit Cocktai l

T Ration

Eggs w/ Sausage
Ham Slice
Apple Dessert
Yellow cake w/ Chocolate Crumbs

Common Items
No fruit juice
No fresh fruit
Fruit Drink, artificially sweetened
Milk, White and Chocolate, whole
Pouch Bread
Jelly
Peanut Butter

Dinner

B Ration

Pork Chops
Gravy
Mashed Potatoes
Peas and Carrots
Cherry Crisp

T Ration

Chicken Breast
Chicken Gravy
Diced Potatoes in Butter Sauce
Corn
Chocolate Cake

Common Items
Fruit Drink, artificially sweetened
Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly
No fresh fruit

24 May, Sunday

Breakfast

B Ration

Creamed Ground Beef
Scrambled Eggs w/ Shortening
Hash Brown Potatoes
Grits
Biscuit w/ Margarine

T Ration

Corned Beef Hash
Pork Sausage Link
Coffee Cake
Flavored Oatmeal

Common Items
Fruit Drink, artificially sweetened w/ added Sugar
Milk, White and Chocolate, whole
Pouch Bread
Jelly
Oatmeal, Instant, plain
No Fresh Fruit
No Fruit Juice

Dinner

B Ration

Shrimp Creole
Rice, white w/ Shortening
Green Beans w/o margarine
Oatmeal cookies

T Ration

Beef Stew
Rice, white
Peas
Yellow Cake w/ Chocolate Crumbs

Common Items
Milk, White and Chocolate, whole
Fruit Drink, artificially sweetened w/ added Sugar
Pouch Bread
Peanut Butter
Jelly

25 May, Monday

Breakfast

B Ration

Scrambled Eggs
Hashed Brown Potatoes
Biscuit w/ Margarine
Grits
Bacon

T Ration

Omelet w/ Bacon and Cheese
Ham slice
Chocolate Cake w/ Vanilla Crumbs
Apple Dessert

Common Items
Fruit drink, artificially sweetened (no sugar added)
Orange juice, canned, blue label
Apple Juice, canned
Cocoa
Oatmeal, regular
Pouch Bread
Peanut butter
Jelly
No Fresh Fruit

Dinner

B Ration

Chicken and Rice
Peas
Fruit Cocktail
Peach Crisp

T Ration

Hamburger
Buns
Beans and Bacon
Fruit Cocktail
Catsup
Mustard
Cheese Spread

Common Items
Fruit drink, artificially sweetened w/o added Sugar
Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly

26 May, Tuesday

Breakfast

B Ration

Scrambled Eggs w/ Shortening
Grilled Luncheon Meat
Hashed Potatoes w/ Shortening
Grits
Biscuit
Peaches

T Ration

Omelet w/ Sausage
Pork Sausage Link
Pears
Spice Cake

Common Items

Fruit drink, artificially sweetened
Orange Juice, canned and Apple Juice, canned
Milk, White and Chocolate, whole
Oatmeal, plain (B item)
Pouch Bread
Peanut Butter
Jelly
No Fresh Fruit

Dinner

B Ration

Pork Chops
Gravy
Mashed Potatoes
Corn w/o Margarine
Sweet Cornbread

T Ration

Chicken Breast
Chicken Gravy
Diced Potatoes in Butter Sauce
Corn
Chocolate Cake

Common Items

Fruit Drink, artificially sweetened
Milk, White and Chocolate, whole
Pouch Bread
Peanut Butter
Jelly

27 May, Wednesday

Breakfast

B Ration

Roast Beef Hash
Scrambled Eggs
Biscuits
Grits
Pears, canned

T Ration

Eggs w/ Bacon and Cheese
Sausage Link
Spice Cake
NO PEARS *(not packed in box)*

Common Items

Orange Juice, from concentrate (T item)
Grape Juice, from concentrate (T item)
Milk, White, whole
Pouch Bread
Peanut Butter
Jelly
No fresh fruit

Dinner

B Ration

Beef w/ Vegie Gravy
Rice
Green Beans
Apple Crisp
Peaches

T Ration

Beef Strips w/ Peppers
Oriental Rice
Sliced Carrots
Chocolate Cake w/ Vanilla Crumbs

Common Items

Fruit Drink, artificially sweetened
Milk, White, whole
Pouch Bread
T-Peanut Butter
T-Jelly

28 May, Thursday

Breakfast

B Ration

Creamed Ground Beef
Hashed Potatoes
Biscuits
Pear Halves
Scrambled Eggs

T Ration

Western Omelet
Potatoes w/ Bacon
Oatmeal, Apples and Cinnamon
Peaches

Common Items
Fruit Drink, artificially sweetened
Milk, White, whole
Oatmeal, plain
Pouch Bread
T-Peanut Butter
Jelly
No Fresh Fruit

Dinner

B Ration

Beef Patties
Potatoes w/ Margarine, w/o Milk
Gravy
Peas
Peanut Butter Cookies
Peaches
Pears

T Ration

Meatballs
White Rice
Green Beans
Chocolate cake w/ Vanilla Crumbs

Fruit Drink, artificially sweetened (lemonade and orange)
Orange juice, Canned
Milk, White, whole
Pouch Bread
Peanut Butter
Jelly